Journal of the Royal Society of Arts

NO. 4912 FRIDAY, 13TH NOVEMBER, 1953 VOL. CI

FORTHCOMING MEETINGS

WEDNESDAY, 18TH NOVEMBER, AT 2.30 p.m. Opening Meeting of the 200th Session. His Royal Highness The Duke of Edinburgh, K.G., President of the Society, in the Chair. Inaugural Address, '*The First President*', by the Right Honble. the Earl of Radnor, K.C.V.O., Chairman of Council.

N.B. Admission will be by special ticket only. A few tickets for Fellows, for seats in the Library, to which the proceedings will be relayed, are still available.

MONDAY, 23RD NOVEMBER, AT 6 p.m. The first of three Cantor Lectures on '*Alloys*', by G. L. Bailey, C.B.E., M.Sc., Director, The British Non-Ferrous Metals Research Association. (The syllabus for these lectures, which will be illustrated by lantern slides, was published in the last issue of the *Journal* on 30th October.)

WEDNESDAY, 25TH NOVEMBER, AT 2.30 p.m. '*Kuwait*', by C. A. P. Southwell, C.B.E., M.C., Managing Director, Kuwait Oil Co., Ltd. Sir Wavell Wakefield, M.P., will preside. (The paper will be illustrated with a film, lantern slides and photographs.)

MONDAY, 30TH NOVEMBER, AT 6 p.m. The second of three Cantor Lectures on '*Alloys*', by G. L. Bailey.

WEDNESDAY, 2ND DECEMBER, AT 2.30 p.m. SELWYN BRINTON LECTURE. '*The British Academy of Arts in Rome, 1797–1936*', by Lieut.-Colonel Ion S. Munro, O.B.E. Sir Gerald Kelly, President, Royal Academy of Arts, will preside.

MONDAY, 7TH DECEMBER, AT 6 p.m. The last of three Cantor Lectures on '*Alloys*', by G. L. Bailey.

BUILDING EXHIBITION TICKETS

A limited number of admission tickets, including tea tickets, for this year's Building Exhibition, which will be held at Olympia from 18th November to 2nd December, have kindly been made available to Fellows by Mr. Hugh R. G. Montgomery, Managing Director of the Building Trades Exhibition Limited.

Fellows wishing to obtain tickets, which are undated, should apply to the Secretary.

INDEXES AND BINDING CASES FOR THE JOURNAL

The index for Volume CI of the *Journal*, which is completed with this issue, will shortly be available and may be obtained, without charge, together with the title page to the volume for binding purposes, on application to the Secretary. Binding cases for the complete volume may be obtained likewise, at a cost of 4*s.* 6*d.* post free.

NEW LIST OF FELLOWS

A new edition of the List of Fellows, corrected to 31st March, 1953, is now available, and copies may be obtained, free of charge, on application to the Secretary.

A new feature of the List is a geographical section, which it is hoped will be particularly interesting to overseas Fellows.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 9th November, 1953. Present: The Earl of Radnor (in the Chair); Mr. F. H. Andrews; Sir Frank Brown; Sir Edward Crowe; Sir John Forsdyke; Mr. P. A. Le Neve Foster; Mr. John Gloag; Sir Ernest Goodale; Mr. A. C. Hartley; Dame Caroline Haslett; Dr. R. W. Holland; Lord Horder; Mr. G. K. Menzies; Mr. F. A. Mercer; Mr. O. P. Milne; Lord Nathan; Sir William Ogg; Mr. E. M. Rich; Professor A. E. Richardson; Sir Andrew Rowell; Sir Harold Saunders; Sir Selwyn Selwyn-Clarke; Sir John Simonsen; Professor Dudley Stamp; Sir Stephen Tallents; Mr. William Will; Sir Griffith Williams; Mr. J. G. Wilson, and Sir John Woodhead; with Mr. K. W. Luckhurst (Secretary).

ELECTIONS

The following candidates were duly elected Fellows of the Society:

Allward, Leslie James, A.R.I.B.A., Hythe End, Middx.
Bentham, Max, M.Sc., M.I.Mech.E., A.M.I.C.E., Cheadle Hulme, Cheshire.
Blakely, Dudley Moore, Eliot, Maine, U.S.A.
Blaker, William Arthur John, Orpington, Kent.
Borchard, George E., London.
Bradshaw, Mrs. Madeleine Elise, London.
Brody, Frederick J., A.R.C.A., Sheffield.
Burley, Gordon, Birmingham.
Champion, James Charles, London.
Cohen, Professor Sir Henry, M.D., F.R.C.P., Liverpool.
Connett, Mrs. Sylvia, London.
Crowe, Colin Tradescant, London.
Dahanukar, Shantaram Mahadeo, B.E., S.M., Bombay, India.
Day, Mrs. Eileen Mary, London.
Ebrahim, Haji Hasanally P., M.L.A., Bombay, India.
Foat, Harold Kenneth, Sheffield.
Francey, James, Baltimore, Maryland, U.S.A.
Fryer, Kenneth George Hessey, O.B.E., T.D., M.I.Mech.E., St. Albans, Herts.
George, Professor Albert Joseph, A.M., Ph.D., Syracuse, U.S.A.
Gimson, Humphrey Morley, A.R.I.B.A., Stanton St. Bernard, Wilts.

Greenwood, Ernest, A.R.C.A., Otford, Kent.
Halcrow, Lady Dorothy Lylleburne, London.
Harrison, Guy James Kay, M.A., Handcross, Sussex.
Hassan, Mohammed Ikramul, B.A., Karachi, Pakistan.
Hill, Oliver, London.
Hobson, The Rev. John Philip Hilary, M.A., Reigate, Surrey.
Horne, David Edgar Alderson, London.
Hunt, Peter Alan, Mosman, N.S.W., Australia.
Jacob, Arthur, Pontypool, Mon.
Jeffery, Sydney, Liverpool.
Julian, Rossall Norman, B.A., London.
Kershaw, Leslie Wray, B.Sc., A.M.I.Struct.E., Sale, Cheshire.
Koenigsberger, Franz, M.Sc., M.I.Mech.E., Stockport, Cheshire.
Lidderdale, Aubrey Douglas, A.M.I.Mech.E., Bromley, Kent.
Maile, William Harry, South Benfleet, Essex.
Martin, Sir Alec, London.
Martin, Clifford Victor, Rickmansworth, Herts.
Midgley, Charles Brian, Huddersfield, Yorks.
Mildner, Raymond Charles, M.Sc., M.I.E.E., London.
Mushlian, Henry Russell, C.P.A., Bramley, Surrey.
Norman, Peter James, B.Sc., A.R.C.S., F.R.I.C., Richmond, Surrey.
North, Bernard Alexander, London.
Oettinger, Cyril, A.F.C., Wallington, Surrey.
Parkhouse, Evan Darrell, M.A., New Malden, Surrey.
Patterson, John, Walsall, Staffs.
Paul, Major Jagjit Singh, M.B.E., Ranchi, India.
Posford, John Albert, M.A., M.I.C.E., Ipswich, Suffolk.
Pugh, William David, F.I.I.A., Sheffield, Yorks.
Randall, Walter Frederick, B.Sc., A.R.S.M., M.I.E.E., Woldingham, Surrey.
Riseley, Richard Arthur, Macclesfield, Cheshire.
Saunders, Dennis William, Birmingham.
Sheldon, Herbert Henry, London.
Sierp, Allan Frederick, Adelaide, Australia.
Simmonds, William George, Stroud, Glos.
Sinden, Peter William, A.T.D., Burgess Hill, Sussex.
Smith, Israel, M.A., Glasgow.
Steward, Major Cecil Walter D'Alterac, Chilworth, Surrey.
Stewart, Donald Rae, M.A., A.R.I.B.A., Bishop's Stortford, Herts.
Stockford, Philip Charles, Pinner, Middx.
Theadom, Charles Frederick, Benin, Nigeria.
Thomas, Miss Winifred Mabel, Carmarthen.
Walker, Miss Dora Muriel, Whitby, Yorks.
Waters, Eric Charles, Birmingham.
Whaler, Ernest Charles, Birmingham.
Whiteley, Frank Geoffrey Lee, Altrincham, Cheshire.

HONORARY CORRESPONDING MEMBERSHIP

Mr. G. W. C. Garrould was appointed Honorary Corresponding Member of the Society in Madras.

BICENTENARY CELEBRATIONS

Further consideration was given to the arrangements for the Bicentenary celebrations.

OTHER BUSINESS

A quantity of formal and financial business was transacted.

REPORT ON THE SOCIETY'S EXAMINATIONS FOR THE SESSION 1952–1953*

INTRODUCTION

The Society's examination programme is a very extensive and complicated one. It includes examinations in 88 different subjects. These are divided, usually into two or three grades, and, in some cases, papers are set on four occasions during the year (Easter, Whitsun, Summer, and Autumn). Altogether, no fewer than 266 papers have to be set and, in practically all, sufficient entries are received to justify holding the examinations. When it is added that examination centres are arranged in most of the larger towns in the United Kingdom and in many places in the Colonies, and that 142,670 entries were received in the session 1952–53, it will be realized that the opening statement in this Introduction to the Report is not an exaggeration.

With the exception of the session 1948–49 this total of entries is the highest on record, but in that year the Society undertook establishment examinations on behalf of the Government for nearly 40,000 Civil Servants. For the Society's own examinations the entry, therefore, is an all-time record. This is particularly satisfactory as it was feared that the raising of the entry fees in 1953 might result in a reduction of entries, but actually there was an increase. These figures provide striking evidence of the keenness of young people of this country to improve their qualifications and to make themselves better fitted for the work on which they are engaged. It must be remembered, too, that a very large proportion of the examinees undertake their study for the examinations in the evenings after a full day's work.

A very obvious question, which is bound to arise in the mind of anyone reading a report on a series of examinations, is 'on the whole how did the candidates acquit themselves?' The answer is to be found in the reports of the examiners which deserve very careful study, especially by teachers of the various subjects who should learn much from them. No brief summary of these reports can be made—the diversity and multiplicity of the examinations renders this impossible. Of course there are many references to common weaknesses and failures, some of which are very hardy annuals, but there is plenty of evidence of careful and skilful teaching in the commercial colleges and evening institutes throughout the country.

Several of the examiners mention, with pleasure, improvement in some of the weaknesses to which they have called attention in previous years, but there

* A fuller report, containing the individual reports of the examiners in the various subjects, will be published as a separate pamphlet by the Examinations Department later this year, and a copy may be obtained by Fellows on application to the Secretary.

are still many references to the 'hardy annuals'. For the guidance of teachers the following are mentioned:

(i) Failure to read the questions correctly and thus a tendency to give answers which are not those asked for by the examiner.

(ii) Obvious inexperience as examinees. This can only be rectified by practice in class in answering examination questions. Doubtless this is not easy in the case of part-time students taught by part-time teachers. It is, however, of great importance to candidates who want to obtain qualifications

(iii) Carelessness in spelling, punctuation, and in other ways, which results in the loss of marks and possible failure, often by candidates who have the necessary knowledge to secure a pass. The examiner in English made the amusing remark, 'Some of these errors, and others in spelling and punctuation, were so absurd that one might imagine that students take a special course on "How to throw away marks in an examination"'. It is, however, very satisfactory to see that in Shorthand, where spelling and punctuation are particularly important, the examiner is able to say that, as a general rule, they were very good.

(iv) In the Language reports the examiners made frequent references to the poorness of the English employed in translations from the foreign language. Not unnaturally they find much to criticize in the translating into the foreign language, for this is a severe test of the candidate's grasp of the subject.

(v) In the Costing, Law, and Book-keeping examinations the examiners all dwell on the candidates' lack of knowledge of principles and urge the need for more time being spent on discussion in class, in place of too much lecturing, and for more time being given to written work.

The listing of these weaknesses must not be taken to mean that there was not a great deal of very good work shown in the scripts. As stated above, there is ample evidence that, under skilful teaching, large numbers of students are successfully learning much that is of value to them and to the community.

In conclusion, a warm word of praise must be paid to the staff of the Examinations Department for the way in which, year after year, they successfully carry out the highly complicated administrative work involved in the Society's vast examination programme.

E. M. RICH

ENTRIES AND PAPERS WORKED

The total number of single-subject entries for the various examinations conducted by the Society in the Session 1952–53 was 142,670, as compared with 130,132 for the Session 1951–52; the number of papers worked, as distinct from entries, was 134,754 and 122,930 respectively.

A table giving a detailed comparison of both entries and papers worked in the two Sessions appears on the next page.

EXAMINATION	Entries		Papers Worked	
	1952–1953	1951–1952	1952–1953	1951–1952
Ordinary (Single-Subject) Series	118,165	102,258	111,642	96,677
School and Senior School Commercial Certificates	8,934	9,070	8,679	8,826
Oral Tests	2,796	2,471	2,568	2,319
L.C.C. and Home Counties Grouped Course ...	8,571	6,578	7,940	6,014
Transport—Scheme A	77	144	70	131
„ „ B	1,666	1,809	1,506	1,689
Teacher's Certificate in Shorthand	615	595	602	572
„ „ „ Typewriting	220	214	214	204
Civil Service Proficiency Tests in Shorthand and Typewriting	—	5,145	—	4,707
Railway Executive (Preliminary examination of candidates under the British Railways Traffic Apprenticeship Schemes)	1,263	1,494	1,170	1,383
British European Airways (Special proficiency tests in Shorthand and Typewriting) ...	221	256	221	250
Royal Air Force Administrative Apprentices (Scheme of endorsement of certificates awarded by the Air Ministry)	142	92	142	92
Totals ...	142,670	130,132	134,754	122,930

GENERAL REMARKS

ENTRIES

The over-all increase in entries of 12,538 was very satisfactory, especially as the figures for 1951–52 included 5,000 entries for the Civil Service Proficiency Tests in Shorthand and Typewriting, which are not now conducted by the Society.

At the Ordinary (Single-Subject) Examinations the increase was substantial in the subjects of Shorthand and Typewriting, and for the Shorthand-Typists' Certificates. It was also reflected in the entries for the great majority of other subjects; in foreign languages, however, there was unaccountably a slight decrease. For English Language, instituted in 1953, there were 3,250 entries in Part I and 949 in Part II, and it is interesting to note that the introduction of this examination in the practice of the language did not adversely affect the number of entries for the ordinary examinations in English, which include questions on English literature.

The entries for the Grouped Course Examinations, for the School and Senior School Commercial Certificate Examinations and for Scheme B of the Transport Examinations, were satisfactory. The slight fall in the number of candidates for the School examinations was undoubtedly due to the cessation this year of the March series, and the big decrease in entries for Scheme A of the Transport examinations was fully expected in view of the announcement last year that this series would be discontinued after 1954.

Examinations have again been arranged under the control of government officials at a number of centres in West Africa; this year there was an over-all increase in the number of entries of approximately 600, compared with last year, in addition to the increasing number of entries there for the School and Senior School Commercial Certificate Examinations. Arrangements have also been made for examinations at other oversea centres under the control of government officials, and in certain foreign countries under the control of an official of the British Embassy or of the local representative of the British Council.

The examinations for traffic apprentices of the Railway Executive were held this year in March, when there were 421 candidates taking the subjects of Geography/General Knowledge, English, and a special paper on railway knowledge.

Further examinations have been conducted in connection with the scheme of endorsement by the Society of certificates awarded by the Royal Air Force to administrative apprentices in training at St. Athan. Examinations in Arithmetic and English took place in December, 1952, and in March and July, 1953.

Special examinations in Shorthand and Typewriting for the award of proficiency pay to employees of British European Airways were held in October, 1952, and April, 1953.

TEACHER'S CERTIFICATE IN SHORTHAND

At the examination in November, 1952, there were 192 candidates, of whom 68 passed in all Sections and two were 'referred' in the Speed Test only; in addition, nine candidates were granted exemption from Part I and 26 from Part II. In May, 1953, there were 410 candidates, of whom 130 passed in all Sections and 14 were referred in the Speed Test only; in addition, 57 candidates were granted exemption from Part I and 19 from Part II.

TEACHER'S CERTIFICATE IN TYPEWRITING

At the examination in November, 1952, which was the last to be held under the old scheme, 31 of the 68 examinees were successful in all Sections. The examination in May, 1953, was based on the revised syllabuses approved last year; for this there were 146 candidates, of whom 54 passed in all Sections, 14 were granted exemption from Part I, and six from Part II. Such exemption is at the discretion of the Panel, and is conditional on the candidates' completing the examination within twelve months.

RECOGNITION OF CERTIFICATES

The certificates awarded by the Society are recognized as denoting certain standards of attainment, standards which the Society has endeavoured to maintain throughout the years. In many instances the certificates are accepted for specific purposes. For example, those in shorthand and typewriting are accepted by the National Joint Council for Local Authorities in connection with their salary scales for shorthand-typists and copy-typists, by the Civil Service Commissioner in Nigeria for the grading of shorthand-typists and stenographers, and, in the advanced stage only, by H.M. Treasury for the award of proficiency pay to civil servants. These certificates, and also those in other subjects, are accepted by a number of business organizations for promotion purposes and for the granting of proficiency pay—and in connection with the scheme launched in September, 1952, by the National Advisory Council for the training and education of Junior Journalists.

The Senior School Commercial Certificate is accepted by certain professional bodies in lieu of their preliminary examination, and the Diploma in Road Transport is accepted by the Institute of Transport as a qualification for admission to Studentship.

The Teacher's Certificate in Shorthand, or in Typewriting, does not, in itself, entitle its holder to be regarded as a qualified teacher, but it is accepted by the Ministry of Education, and by local education authorities in all parts of Great Britain and Northern Ireland, as a teaching qualification in that particular subject.

REVISION OF SYLLABUSES

During the Session consideration was given to a general revision of the syllabuses in Accounting, Commerce, Public Administration, and of the English paper in the examination for the Shorthand-Typist's Certificate, and the recommendations of the sub-committees concerned were approved by the Examinations Committee at their meeting in July, 1953. The Society is deeply indebted to members of the various committees connected with the examinations for their help and advice.

REVISED CONSTITUTION OF EXAMINATIONS COMMITTEE

A revision of the constitution of the Examinations Committee has now been approved. The principal changes are the inclusion of representatives of additional commercial and professional bodies, a modification of the method of determining representation of local education authorities, and an alteration in the date on which the Committee comes into office each year. The first meeting of the reconstituted Committee was held on 7th July, 1953.

GENERAL CERTIFICATE OF EDUCATION

Arrangements have now been made for the formation of a Board to assume responsibility for the conduct of examinations for the award of a General Certificate of Education suitable for students in institutions of further education, and in secondary commercial, secondary technical, and secondary modern schools. On this board will be representatives of the Society, together with those of the six other national and regional examining bodies in commercial and technical subjects, representatives of various associations connected with education, and also of the universities; in addition, invitations have been sent to certain professional bodies. In the first years the City and Guilds of London Institute will finance the scheme, with the Director of the Institute as Secretary of the Board, but when the new examinations are firmly established it is thought that the Board will be self-supporting. It is hoped that the regulations, syllabuses, etc., will be ready for distribution by about the middle of 1954 and that the first examinations will be held in 1955. In the meantime, application is being made to the Secondary School Examinations Council for formal recognition of the new Board for the purpose of conducting examinations for the award of the General Certificate of Education.

ASSOCIATE MEMBERSHIP

Four Silver Medallists at the examinations in 1952 were eligible for the award of Associate Membership of the Society, and were elected last autumn.

TABLE OF RESULTS OF THE L.C.C. GROUPED COURSE EXAMINATIONS, 1953

COMMERCIAL AND GENERAL GROUPS—STAGE I

SUBJECTS	Passed with Credit			Passed			Not Passed			Papers worked at Whitsun and Summer combined
	Whitsun	Summer	Total	Whitsun	Summer	Total	Whitsun	Summer	Total	
Arithmetic	3	2	5	3	3	6	15	16	31	42
Arithmetic & Accounts	1	9	10	10	21	31	3	36	39	80
Commerce	4	—	4	7	25	32	—	16	16	52
Economic Geography	—	4	4	2	4	6	7	7	14	24
English	5	10	15	23	110	133	14	130	144	292
French	1	—	1	12	1	13	12	4	16	30
History	—	1	1	—	5	5	—	3	3	9
Shorthand, 60 w.p.m.	—	18	18	1	20	21	2	37	39	78
,, 50 ,,	—	9	9	2	19	21	7	82	89	119
Typewriting	4	16	20	2	47	49	6	143	149	218
Totals	18	69	87	62	255	317	66	474	540	944

COMMERCIAL AND GENERAL GROUPS—STAGE II

SUBJECTS	1st Class			2nd Class			Not Passed			Papers worked at Whitsun and Summer combined
	Whitsun	Summer	Total	Whitsun	Summer	Total	Whitsun	Summer	Total	
English	—	—	—	2	5	7	—	3	3	10
Shorthand, 100 w.p.m.	—	—	—	—	2	2	—	—	—	2
,, 80 ,,	—	—	—	—	6	6	—	5	5	11
Typewriting	—	1	1	—	3	3	2	13	15	19
Totals	—	1	1	2	16	18	2	21	23	42

TECHNICAL GROUP

SUBJECTS	Passed with Credit			Passed			Not Passed			Papers worked at Whitsun and Summer combined
	Whitsun	Summer	Total	Whitsun	Summer	Total	Whitsun	Summer	Total	
English	35	88	123	91	385	476	11	144	155	754
Mathematics	77	228	305	17	117	134	4	81	85	524
Science	19	118	137	31	92	123	14	123	137	397
Technical Drawing ...	18	95	113	67	251	318	40	256	296	727
Trade Calculations ...	16	82	98	15	67	82	6	50	56	236
Totals	165	611	776	221	912	1133	75	654	729	2,638

TABLE OF RESULTS OF THE HOME COUNTIES GROUPED COURSE EXAMINATIONS, 1953

COMMERCIAL AND GENERAL GROUPS—STAGE I

SUBJECTS	Passed with Credit			Passed			Not Passed			Papers worked at Whitsun and Summer combined
	Whitsun	Summer	Total	Whitsun	Summer	Total	Whitsun	Summer	Total	
Arithmetic	—	5	5	3	11	14	9	5	14	33
Arithmetic & Accounts	—	8	8	1	14	15	4	19	23	46
Commerce	—	1	1	—	7	7	1	5	6	14
Economic Geography	1	9	10	5	7	12	1	2	3	25
English	—	10	10	14	43	57	8	33	41	108
French	—	1	1	—	2	2	—	9	9	12
History	4	2	6	5	2	7	3	3	6	19
Shorthand, 60 w.p.m.	—	15	15	1	6	7	1	3	4	26
„ 50 „	—	6	6	2	9	11	4	24	28	45
Typewriting	—	7	7	5	20	25	3	37	40	72
Totals	5	64	69	36	121	157	34	140	174	400

TECHNICAL GROUP

SUBJECTS	Passed with Credit			Passed			Not Passed			Papers worked at Whitsun and Summer combined
	Whitsun	Summer	Total	Whitsun	Summer	Total	Whitsun	Summer	Total	
English	71	92	163	343	367	710	82	72	154	1,027
Mathematics	194	260	454	135	119	254	98	61	159	867
Science	62	125	187	126	134	260	146	89	235	682
Technical Drawing ...	47	72	119	219	213	432	174	174	348	899
Trade Calculations ...	69	176	245	49	87	136	39	21	60	441
Totals	443	725	1,168	872	920	1,792	539	417	956	3,916

TABLE OF RESULTS OF THE ROAD TRANSPORT EXAMINATIONS, 1953

Scheme A	*Papers Worked*	*1st Class*	*2nd Class*	*Not Passed*
Group I—Economic Geography of the U.K. ..	5	—	4	1
Commerce and Business Routine ..	6	1	4	1
Elements of Transport	12	1	7	4
Group II—Principles of Accounts	7	3	4	—
Law Relating to Road Transport ..	9	1	7	1
Economics Applied to Road Transport	8	2	4	2
Group III—Elementary Statistics	11	1	9	1
Law of Inland Carriage	5	1	4	—
Road Transport Operation	7	6	1	—
Totals	70	16	44	10

Scheme B				
1st Year—Road Transport Operation (Passenger)	301	42	147	112
„ „ „ (Goods) ..	72	3	46	23
Elements of Road Transport Engineering	182	34	84	64
Road Transport Accounts and Statistics	275	17	157	101
2nd Year—Road Transport Operation (Passenger)	145	55	68	22
„ „ „ (Goods) ..	53	4	33	16
Elements of Road Transport Engineering	120	26	41	53
Road Transport Accounts and Statistics	124	20	51	53
3rd Year—Road Transport Operation (Passenger)	59	32	22	5
„ „ „ (Goods) ..	30	2	18	10
Road Transport Accounts and Statistics	65	4	39	22
Economics Applied to Road Transport	80	9	46	25
Totals	1,506	248	752	506

SENIOR SCHOOL AND SCHOOL COMMERCIAL CERTIFICATE EXAMINATIONS, 1953

NUMBER OF FULL CERTIFICATES AWARDED

Senior School Commercial Certificate

Candidates, 172; First-class Certificates, 2; Second-class Certificates, 45

School Commercial Certificate

Candidates, 995; First-class Certificates, 40; Second-class Certificates, 418

TABLE SHOWING THE NUMBER OF PAPERS WORKED IN THE SENIOR SCHOOL AND SCHOOL COMMERCIAL CERTIFICATE EXAMINATIONS IN 1953 TOGETHER WITH THE RESULTS

SUBJECTS	SENIOR SCHOOL COMMERCIAL CERTIFICATE EXAMINATION				SCHOOL COMMERCIAL CERTIFICATE EXAMINATION			
	Number of Papers worked	Passed 1st Class	Passed 2nd Class	Not Passed	Number of Papers worked	Passed with Credit	Passed	Not Passed
Arithmetic	168	19	68	81	979	215	445	319
English	196	5	98	93	956	29	706	221
Book-keeping	162	32	56	74	893	230	386	277
Commerce	177	3	123	51	690	31	512	147
Shorthand*—								
100 & 80 w.p.m. ...	121	3	47	71	—	—	—	—
60 w.p.m.	—	—	—	—	295	149	60	86
50 ,, ...	—	—	—	—	543	111	94	338
Typewriting	133	3	30	100	888	169	291	428
Economic Geography ...	173	22	76	75	929	118	401	410
French†	19	3	9	7	305	23	156	126
German	—	—	—	—	1	—	—	1
History	9	2	5	2	250	44	112	94
History of the British Empire	75	7	26	42	193	8	57	128
Mathematics	60	5	15	40	234	27	86	121
Science	9	—	—	9	109	4	50	55
Spanish	40	—	6	34	61	—	17	44
Welsh	—	—	—	—	11	4	5	2
Totals ...	1,342	104	559	679	7,337	1,162	3,378	2,797

*The figures in the Senior School columns for First and Second Class are for passes at 100 and 80 words per minute respectively; in the School columns the figures are for Passed with Credit and Passed at the speeds shown. (A Credit is awarded for high marks for shorthand notes at 60 and 50 words per minute.)

†One candidate for the School Commercial Certificate took the Oral Test in French and passed.

DETAILS OF THE ORDINARY (SINGLE-SUBJECT) EXAMINATIONS, 1953

(INCLUDING AUTUMN SERIES, 1952)

SUBJECT	Stage	Papers worked	1st Class (or Passed with Credit in Stage I)	2nd Class (or Passed in Stage I)	Not Passed	Total number of papers worked in each subject	
						1953	1952
Accounting	III	97	5	46	46	**97**	111
Advertising	III	22	2	12	8	**22**	22
Arithmetic	I	3,891	543	1,292	2,056		
"	II	832	93	226	513	**4,846**	4,231
"	III	123	15	51	57		
Book-keeping	I	7,171	1,302	2,951	2,918		
"	II	3,170	846	1,289	1,035	**11,415**	12,314
"	III	1,074	24	407	643		
Commerce	I	1,162	93	535	534		
"	II	573	16	237	320	**1,874**	1,899
"	III	139	3	80	56		
Commercial Law ...	II	171	25	91	55		
" "	III	30	1	18	11	**201**	174
Common Law	III	20	1	6	13	**20**	13
Company Law	II	33	9	18	6		
" "	III	34	6	20	8	**67**	56
Costing	II	78	3	49	26		
"	III	38	—	25	13	**116**	99
Danish	I	12	1	8	3		
"	II	3	2	1	—	**15**	10
Dutch	I	11	4	2	5		
"	II	13	2	9	2	**24**	32
Economic Geography ...	I	611	90	202	319		
" " ...	II	227	36	90	101	**905**	723
" " ...	III	67	11	36	20		
Economic & Social History	II	153	32	59	62		
" " "	III	25	5	9	11	**178**	34
Economic Theory ...	II	334	37	142	155		
" " ...	III	116	3	49	64	**450**	415
Elements of English Law...	II	91	14	46	31	**91**	65
English	I	4,329	289	2,384	1,656		
"	II	1,652	83	765	804	**6,612**	6,459
"	III	631	43	391	197		
English for Foreigners ...	I	543	125	221	197		
" " " ...	II	734	141	367	226	**1,539**	1,164
" " " ...	III	262	24	131	107		
English Language, Part I	—	3,236	—	2,088	1,148		
" " " II	—	935	69	491	375	**4,171**	—
Esperanto	I	12	4	4	4		
"	II	11	2	5	4	**29**	97
"	III	6	—	5	1		
French	I	886	101	325	460		
"	II	375	29	95	251	**1,504**	1,742
"	III	243	32	88	123		
German	I	214	71	107	36		
"	II	118	34	45	39	**383**	445
"	III	51	10	28	13		
History	I	113	10	43	60	**113**	117
History of the British Empire	I	7	1	1	5		
" " " "	II	56	3	16	37	**94**	141
" " " "	III	31	8	11	12		
History of the U.S.A. ...	I	—	—	—	—	—	5
Italian	I	178	65	82	31		
"	II	47	11	28	8	**250**	251
"	III	25	3	17	5		

DETAILS OF THE ORDINARY (SINGLE-SUBJECT) EXAMINATIONS, 1953

(INCLUDING AUTUMN SERIES, 1952)—*continued*

SUBJECT	Stage	Papers worked	1st Class (or Passed with Credit in Stage I)	2nd Class (or Passed in Stage I)	Not Passed	Total number of papers worked in each subject 1953	1952
Law of Evidence and Civil Procedure	III	6	1	2	3	6	3
Norwegian	I	—	—	—	—	—	8
Public Administration ...	III	67	7	44	16	67	31
Real Property and Conveyancing	III	14	—	7	7	14	16
Russian	I	39	11	17	11		
,, ...	II	25	7	7	11	73	90
,, ...	III	9	3	5	1		
Shipping Law & Practice...	III	5	—	3	2	5	8
Spanish	I	305	69	115	121		
,, ...	II	107	29	35	43	476	528
,, ...	III	64	3	29	32		
Statistics	II	60	14	35	11	72	54
,, ...	III	12	3	8	1		
Stock Exchange Law and Practice	I	19	1	8	10		
,, ,, ,, ...	II	22	3	8	11	57	78
,, ,, ,, ...	III	16	4	6	6		
Swedish	I	10	4	2	4		
,, ...	II	6	1	3	2	23	10
,, ...	III	7	—	5	2		
Typewriting	I	18,858	4,018	5,710	9,130		
,, ...	II	11,848	1,719	3,803	6,326	35,156	30,091
,, ...	III	4,450	420	1,613	2,417		
Welsh	I	—	—	—	—	—	5

	Papers worked	Passed with Credit	Passed	Not Passed		
Shorthand :—						
50 words per minute ...	8,410	1,628	2,309	4,473		
50 ,, ,, ,, (Typed Transcript) ...	212	39	77	96		
60 words per minute ...	7,243	2,570	2,207	2,466		
60 ,, ,, ,, (Typed Transcript) ...	250	97	100	53		
	Papers worked		Passed	Not Passed	38,184	33,078
80 words per minute	12,125		6,121	6,004		
100 ,, ,, ,, ...	5,511		2,680	2,831		
120 ,, ,, ,, ...	4,021		886	3,135		
140 ,, ,, ,, ...	412		125	287		
Shorthand-Typist's Certificate						
Stage II	2,213		1,265	948	2,493	2,058
Stage III	280		75	205		
TOTALS ...					111,642	96,677

THE KEMANO-KITIMAT HYDRO-ELECTRIC POWER DEVELOPMENT

A paper by

F. L. LAWTON, P.Eng., Fel.A.I.E.E., M.E.I.C.

Chief Engineer, Power Department, Aluminium Laboratories Limited, Montreal, read to the Commonwealth Section of the Society, on Friday, 27th March, 1953, with G. G. Crean, Counsellor, Canada House, in the Chair

THE CHAIRMAN: It is a double pleasure for me to come here to-day: first to introduce a fellow Canadian, and secondly to introduce someone who has been so closely associated with one of the great projects which are changing the face of Canada to-day.

Mr. Lawton is a distinguished engineer who has been associated with hydro-electric projects in Canada over a period of thirty years, and indeed, when one looks at his biography, it is very much like the history of hydro-electric power development in Canada itself. He is, at the present time, the Chief Engineer of the Power Department of Aluminium Laboratories Ltd., at Montreal. Since the inception of the project for establishing an aluminium reduction plant at Kitimat, Mr. Lawton has been consultant on a number of major engineering problems involved in developing power to run the plant. No one is in a better position than Mr. Lawton to tell us about the problems which have been faced in realizing this vast project.

The following paper, which was illustrated with lantern slides, was then read:

INTRODUCTION

The Nechako-Kemano hydro-electric power development in west central British Columbia, with the power-transmission facilities and the aluminium-reduction plant at Kitimat, marks an outstanding event in the amazing industrial development of aluminium, which now ranks as the most widely-used non-ferrous metal in the world, and among metals second in volume to steel alone.

Bauxite, the basic ore of aluminium of commercial grade, is found only in the tropical and sub-tropical zones, although some deposits of limited volume do occur in areas fringing the sub-tropics. About four pounds of bauxite are required for every pound of aluminium. The production of aluminium ingot requires some 10 kWh. for every pound of metal. Other raw materials amount to roughly six times the weight of aluminium ingot. Here, then, are two of the basic ingredients of aluminium—cheap power and cheap transportation.

The first requires large blocks of cheap hydro-electric power, the basis on which the aluminium industry has been built. Historically, the industry has been located where cheap power could be created. Constant co-operation with

surrounding communities and active endeavours to encourage new industries on the part of the aluminium people have always led to the growth and development of thriving industries within the area of the power development. In time, the power has become more valuable for other industries requiring less energy per unit of product, and the aluminium industry has had to look elsewhere for its power.

The first great development of the aluminium industry in the United States was at Niagara Falls, but no aluminium is made there to-day. The industry went to water power at Baden, North Carolina, and Alcoa, Tennessee, and then to the Pacific Northwest, to use Columbia River power. With cheap water power in sufficient quantities unavailable, it has turned to natural gas as fuel for diesel engines or steam-power stations, as at Point Comfort in Texas and Chalmette in Louisiana. A late development is the use of low-grade lignite fuel, after processing, in the steam-power plant serving the new Texas reduction plant of the Aluminium Company of America.

In Canada, the industry had its beginnings in 1900, when the construction of the first aluminium-reduction plant was started at Shawinigan Falls in Quebec. As the industry expanded, it turned to the water-power resources of the Saguenay River in Quebec. A generating station was built at Isle Maligne, Quebec, at the headwaters of the Saguenay River. The first aluminium was produced at Arvida in 1926, in a plant which is to-day the world's largest. The expansion of Canadian aluminium production during the Second World War involved the building of additional smelter capacity and the completion of the Shipshaw power development, the first stage of which was commenced in 1926. The final stage of this power development comprised the construction of the 1,200,000 h.p. Shipshaw generating station, and brought the total development up to 1,500,000 h.p. The current expansion program in the Saguenay entails about 500,000 h.p. now under construction at two sites on the Peribonka River, the principal tributary of the Saguenay. Upon completion of the two new sites on the Peribonka River in the early spring of 1953 the aluminium industry will have built a Saguenay power system with a total installed capacity of 2,580,000 h.p.

The second requirement for the economic production of aluminium is cheap transportation. At present the bauxite used at the Arvida aluminium-reduction plant is mined in British Guiana, shipped to Arvida and there processed to alumina. However, Kitimat will use bauxite deposits now being developed in Jamaica, processed to alumina in the plant being erected nearby, and shipped to the aluminium-reduction plant by ocean freighter, through the Panama Canal and up the Pacific Coast. Cryolite from Greenland, fluorspar from Newfoundland and elsewhere, and the other raw materials for aluminium ingot, from many sources of supply, also require ocean transport.

Large aluminium-reduction plants require many thousands of workmen, with necessary homes, schools, churches, recreational facilities and all the needs of a modern well-balanced community. So ample suitable space for plant and community must be available.

Since the Second World War the demand for aluminium has exceeded present

world capacity. Over the past twenty-five years the consumption of aluminium has increased on an average nine per cent every year, and the probability is that the growth trend will continue upwards. Of Canadian production, only about fifteen per cent is consumed in Canada, the Canadian exports in 1951 ranking fourth among all exports, only newsprint and other forest products, wheat, and nickel leading it.

Cheap water power and cheap transportation do not ordinarily occur near areas suitable for plant and siting towns. All factors have to be weighed in the balance. Considerable time is required for the development of power and reduction-plant facilities, once a decision is reached to develop a power site. That is why Aluminium Limited has for years sought out and developed bauxite resources, and investigated potential water powers all over the world, in order to supply the growing demand for aluminium.

That is also why the Aluminium Company of Canada, Limited (commonly known as Alcan), the principal producing subsidiary of Aluminium Limited, is to-day well advanced on the construction of the Nechako-Kemano hydro-electric power development, the aluminium-reduction plant at Kitimat and related facilities such as harbour and town, and the transmission system linking the power plant and the reduction plant. With an ultimate firm delivery at Kitimat of 1,670,000 h.p. and installed capacity of 2,240,000 h.p., the decision of Aluminium Limited early in 1951 to proceed with the first stage of the overall project constitutes a notable milestone in the growth of the aluminium industry. This decision marked the start of construction on the greatest hydro-electric power development ever financed by private capital.

On April 21, 1951, the decision was reached to proceed, on the basis of a power development involving equipment for 450,000 h.p. of the initial stage of the ultimate 1,670,000 h.p. firm capacity, transmission facilities, aluminium-reduction plant, town, and port.

As already observed, the Kitimat aluminium-reduction works will draw many of the raw materials it requires from Commonwealth sources—alumina produced in Jamaica from Jamaica bauxite, fluorspar from Newfoundland, water power developed in British Columbia, etc. Its output will add to supplies available for fabrication of finished products in the United Kingdom, where the industry employs some 60,000 people, and plays its part in the British drive for export markets.

Those engaged in the design and manufacture of heavy equipment will be interested to learn that half of the initial 300 kV. power cable order, one of the initial step-up transformer banks, one of the generators and part of the pressure-conduit liner steel for Kemano are being secured from United Kingdom sources. Moreover, half of the pot-room cranes, the unloading crane for the harbour, the bulk-alumina unloading equipment, a number of other cranes and considerable miscellaneous equipment for Kitimat aluminium-reduction works are being purchased in Great Britain. Alcan is buying as much as possible in the United Kingdom, in view of United Kingdom purchases of aluminium and other Canadian products.

PHYSIOGRAPHIC SETTING

On the western slopes of the majestic Coast Range mountains most of the valleys reach sea-level close to or somewhat east of the crest, constituting the great fjords which sharply indent the coast line. Similarly, large valleys on the eastern slopes of the range are occupied by long, narrow and deep lakes, with westerly extremities close to the crest, extending out over the Interior Plateau.

Here we see an unusual topographic development, in which the deep valleys of the western slope head inland to within a few miles of the shallower lake-occupied valleys on the eastern slope. It arises from the heavy glacial action to which the region was subjected in times past, when the whole of British Columbia, except the highest peaks, was covered by a continuous ice cap. It creates the water power which is being harnessed in the Nechako-Kitimat development.

By damming the Nechako River near the head of the Grand Canyon, a great storage reservoir (Fig. 1) will be created which will impound the run-off of the Eutsuk-Tetachuck-Euchu and Tahtsa-Whitesail-Ootsa-Natalkuz drainage systems, at full reservoir level 2,800 feet above sea level. This permits the flow to be reversed through Tahtsa River and Lake, and diverted through power tunnels piercing the Coast Range (Fig. 3).

PRECIPITATION, RUN-OFF AND REGULATION

Precipitation over the watershed ranges from 100 in. per annum or more on the higher, westerly portions, to 20 in. on the lower, easterly portions. The area of the watershed above Kenney dam is 5,475 sq. mi. to which the run-off from the 290 sq. mi. Nanika-Kidprice Lakes watershed can be diverted.

With the storage reservoir created by Kenney dam providing 873×10^8 c.f. capacity, and an average total run-off of 7,470 c.f.s., it will be possible to utilize a regulated flow of 6,920 c.f.s. through the turbines.

The annual average reservoir level will be at 2,795 feet above sea-level, overall variation under average conditions being about 6·5 feet, and under minimum water conditions about 17 feet. As the turbines are located with a nozzle setting at 210 feet above sea-level, the gross head on the turbines, under average reservoir level, is 2,585 feet.

With 6,920 c.f.s. of water available under a net head of about 2,500 feet, an estimated 1,718,000 h.p. can be generated.

STORAGE, DIVERSION AND CONTROL DAMS

Fig. 1 shows the location of the several storage, diversion and control dams required in the creation of the 20,000,000 acre-feet storage reservoir, whereby the run-off of the tributaries of the Nechako River is impounded and raised to full reservoir level at 2,800 feet. The reservoir will be 15 feet above the normal level of Tahtsa Lake, through which the flow is reversed to permit diversion through the power tunnels piercing the Coast Range, thence the generating units and into the Kemano River.

The Kenney storage and diversion dam (Fig. 2) is of the rockfill type, in which the load-carrying element is a heavy rockfill, thoroughly sluiced, supporting

on the upstream slope an impervious section of rolled-earth construction enclosed between suitable filter layers. The upper section is loaded with quarry-run rock to retain the filter layers and impervious core, and resist wave erosion. The impervious core extends from a cut-off trench in sound rock to near the top of the dam.

The function of the downstream filter layers is to prevent the impervious core material from being forced into the rockfill by the water pressure, whereas the upstream filter layers perform a similar function with respect to the upstream blanket of quarry-run rock. The downstream filters comprise three layers: immediately downstream from the impervious core a layer of sand $\frac{3}{4}$ in. and smaller; next crushed rock or gravel 3 to $\frac{3}{4}$ in.; and, finally, adjoining the main rockfill a layer of 10 to 3 in. selected rock. The upstream filter is similar but in the reverse sense, with the omission of the layer of 10 to 3 in. rock.

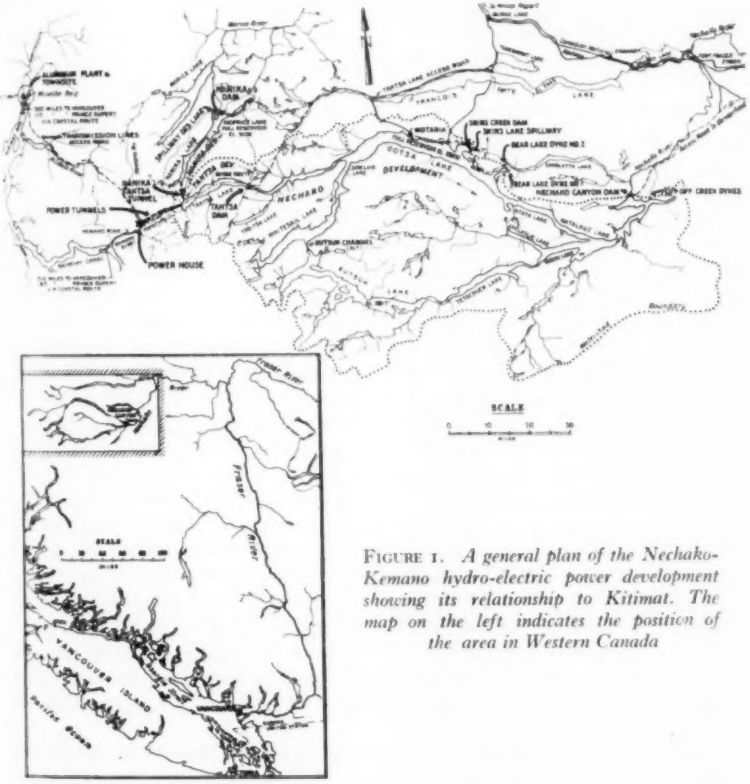


FIGURE 1. *A general plan of the Nechako-Kemano hydro-electric power development showing its relationship to Kitimat. The map on the left indicates the position of the area in Western Canada*

FIGURE 2. *Upstream side of Kenney Dam, with reservoir water level at 2,657·5 feet above sea-level*

Below the impervious core, effective cut-off is assured by a grout curtain. This grout curtain was developed by grouting the upper 25 feet of rock at pressures of about 20 p.s.i., then to necessary depth by deep holes drilled through the consolidated upper zone, using higher grouting pressures.

Because of its location on a major head-water tributary of the important Fraser River, a very high degree of reliability has been built into the dam, which has a maximum hydraulic height above bedrock of about 310 feet at full reservoir level of 2,800 plus a 7-foot flood surcharge, being exceeded by San Gabriel No. 1 in California (1933–37) at 380 feet and Salt Springs in California (1931) at 328 feet approximately. Freeboard at the abutments is 19·5 feet, with a super elevation of 5 feet at the centre of dam to provide for settlement.

Crest length is about 1,550 feet. Crest width of the dam is 40 feet. The slope of the upstream face is 1 in 2·5, increasing the overall factor of safety considerably beyond the originally contemplated 1 in 1·5, in view of the importance of the dam. The slope of the downstream face averages 1 in 1·75. This average was obtained by a series of repose slopes and berms. The foundation of the dam was trimmed to not exceed slopes of 1 in 1·5 adjacent to the impervious core, to eliminate the possibility of tension cracks in the impervious core due to differential settlement. The longitudinal axis of the dam was given a slight camber upstream, thus putting the core under axial compression and decreasing the possibility of tension stresses in the core.

Model tests, made at the University of California, indicated the dam (with rest width of 30 feet upstream slope of 1 in 1·5 and downstream slope of 1 in 1·4)

to be free from movement (sliding) with a pressure on the upstream face of well over ten times that arising from water. Similarly, shaking-table model tests showed the dam would be entirely safe with an acceleration equal to gravity, ten times the usual allowance for dams in seismically-active regions. The dam and other components of the power development are not located in a seismically-active area.

Materials for construction of this dam were drawn from closely adjacent quarries and borrow areas. Entirely suitable rock and impervious material, combined with thorough control, will add to the reliability and life. About 4,000,000 cubic yards of fill was used.

Unwatering of the site was effected by a diversion tunnel in the left-hand bank, completed during 1951. This tunnel, of horseshoe cross-section, about 1,430 feet long, with a slope of 0·0135, was provided with closure means at the upstream portal and was eventually plugged by a concrete plug below the impervious core and grouted zone. The rockfill cofferdam below the tunnel entrance portal and above the dam site proper had its crest at 2,590 feet above sea-level.

The storage reservoir has been filling since October 8th, 1952, when the diversion tunnel at Kenney Dam was closed, the dam itself being completed before the end of the year.

Discharge of surplus or flood waters will be effected by a spillway with two 35-foot by 35-foot taintor gates; its sill is 2,765 feet above sea-level with a short free-crest section at 2,800 feet. It is located at Skins Lake and the discharge will pass through the Cheslatta Lake Dam. Spillway capacity at full reservoir level (2,800 feet) is some 43,000 c.f.s.

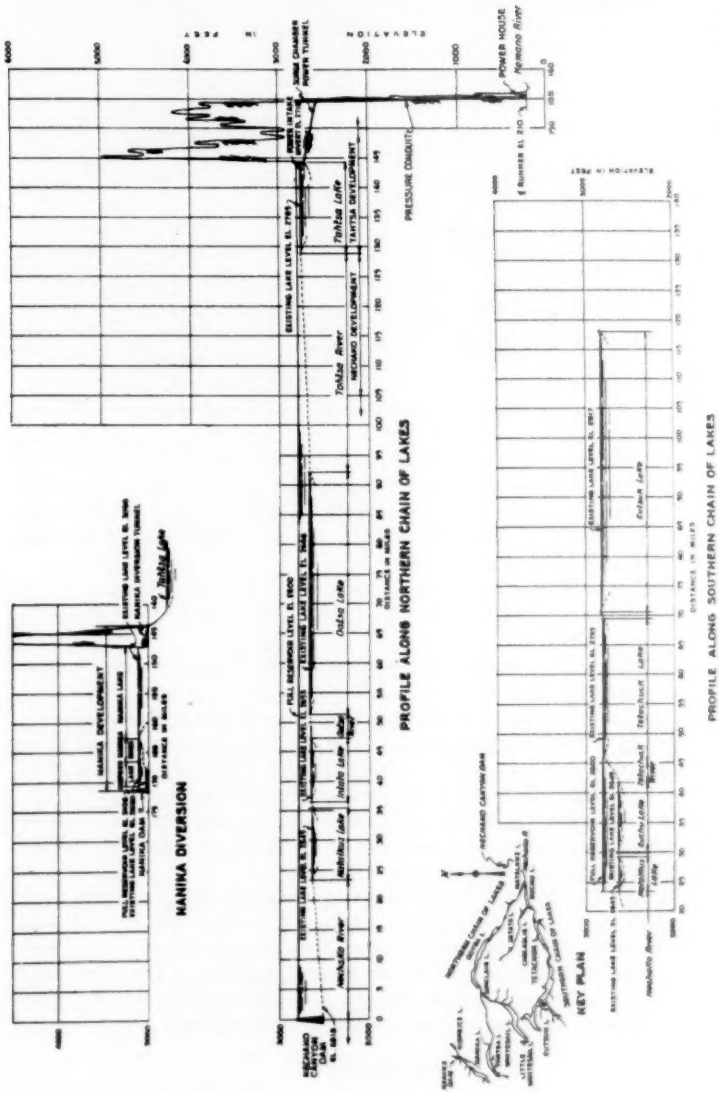
Low points in the flow line of the reservoir require the construction of six low and short rock or earthfill dykes, with sloping impervious core, from locally available materials.

The storage and diversion of the Nanika-Kidprice Lakes water will require a dam similar to Kenney Dam, about half a mile below the outlet of Kidprice Lake where good foundation rock exists. This dam will have a maximum height of about 155 feet and a crest length of about 800 feet, the volume of all fill in place amounting to about 500,000 cubic yards. To handle flood waters from the Nanika-Kidprice diversion a low concrete free-crest spillway will be constructed at the west end of Des Lake, the discharge returning to the Nanika River several miles below the storage and diversion dam. Crest of the spillway will be at normal full reservoir level of 3,106 feet.

To divert water from the Nanika-Kidprice watershed, it is planned to drive a free discharge tunnel uphill from the Tahtsa portal. The invert at the Nanika Lake inlet portal will be low enough to carry the maximum natural outflow with reservoir level maintained at the Des Lake spillway crest at 3,106 feet. The tunnel will be about 3·8 miles in length, and have an equivalent diameter of 13 feet. No work on this part of the project is contemplated at this time.

POWER TUNNELS

There will be two unlined power tunnels, one of which is now under construction, with concrete paved inverts, each about 10·1 miles in length from the


PROFILE ALONG NORTHERN CHAIN OF LAKES
PROFILE ALONG SOUTHERN CHAIN OF LAKES
NANIKA DIVERSION
KEY PLAN
ELEVATION IN FEET
DISTANCE IN MILES
Tahtsa Lake
Ootsa Lake
Nechako River
Nanika Lake
Kenney Dam
Kemano River
POWER HOUSE
PRESSURE CONDUITS
TAHTSA DEVELOPMENT
KEMANO DEVELOPMENT
NANIKA DEVELOPMENT
NECHAKO CANYON DAM
EXISTING LAKE LEVEL EL. 2785
EXISTING LAKE LEVEL EL. 2800
EXISTING LAKE LEVEL EL. 2820
EXISTING LAKE LEVEL EL. 2830
EXISTING LAKE LEVEL EL. 2840
EXISTING LAKE LEVEL EL. 2850
EXISTING LAKE LEVEL EL. 2860
EXISTING LAKE LEVEL EL. 2870
FULL RESERVOIR LEVEL EL. 2800
FULL RESERVOIR LEVEL EL. 2820
FULL RESERVOIR LEVEL EL. 2840
FULL RESERVOIR LEVEL EL. 2860
FULL RESERVOIR LEVEL EL. 2880
FULL RESERVOIR LEVEL EL. 2900
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FULL RESERVOIR LEVEL EL. 2940
FULL RESERVOIR LEVEL EL.

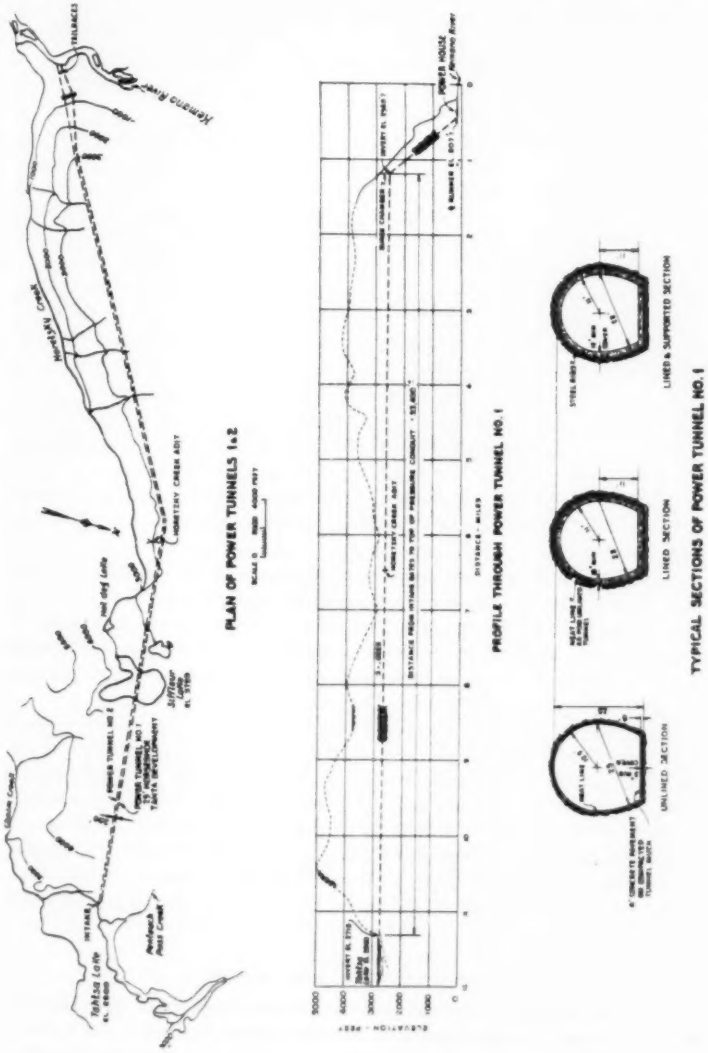


FIGURE 4. *Plan, profile and sections of Power Tunnel No. 1*

intake at the west end of Tahtsa Lake to the base of the surge chamber. These tunnels pierce the Coast Range mountains on the right-hand side of Horetzky Creek (Fig. 4). The intake consists of a concrete structure located about 1,000 feet west of Penteuch Pass Creek. A short channel about 80 feet wide at the invert will be excavated between Tahtsa Lake and the intake structure, which is being built in the dry.

The intake structure will be equipped with trash racks, guides for bulkheads and for two 14-foot by 26-foot fixed-wheel gates, each controlling the flow to one of the two power tunnels, the invert of which near the intake structure will be at 2,718 feet above sea-level. The gate sill for No. 1 tunnel is at 2,725 feet in order to use Tahtsa Lake water only in the first stage; the other is at 2,740 feet.

An economic analysis resulted in the conclusion that twin 25-foot diameter tunnels would be most economical, and possibly somewhat more reliable than a single 35-foot diameter tunnel. Friction losses and tunnel costs were based on the use of steel supports and/or 18 in. concrete lining for ten per cent of the total length, where required for support or to cut off influxes of water.

The No. 1 power tunnel is the north tunnel of the ultimate twin 25-foot diameter tunnels, spaced 300 feet apart. Its invert slopes uniformly 0·0025 downward towards the surge shaft. The cross-section has an area of about 527 sq. ft., with a volume of excavation per lineal foot of 19·5 cu. yd. With average outbreak, the volume of rock to be excavated per lineal foot of tunnel is 23·0 cu. yd. Although each tunnel will normally carry 3,500 c.f.s., it is designed to take about 4,500 c.f.s. maximum.

The tunnel is being driven from four headings. These are east from the surge shaft; both directions from a 1,600 foot adit in the Horetzky Creek valley near the midpoint of the tunnel length; and west from the intake end. Concrete plugs and removable bulkheads will be installed in the west adit, and possibly in the Horetzky adit, for use in initial sluicing of the tunnel and for maintenance access during operation of the plant (Fig. 5).

The geological formation through which the tunnels are being driven consist of metamorphosed volcanic and sedimentary types, such as greenstone, schist, tuff, quartzite and minor limestone, at the intake end and for a considerable distance west; at the Kemano or surge chamber end the rock is a granodiorite of the Coast Range batholith tending to a quartz diorite proceeding easterly. The older volcanic and sedimentary rocks require a moderate amount of support; the granodiorite relatively little; both drill and break advantageously. In the granodiorite a world's record advance of 282 feet for a six-working-day week has been made.

PRESSURE CONDUITS *versus* PENSTOCKS

Up to the pressure conduits, including the related surge chambers, the pressure conduits themselves,the manifolds and the valve chamber, the Nechako-Kemano power development follows very closely North American high-head practice, apart from the capacity of the storage reservoir, the size of the Kenney Dam, and the length and size of the power tunnels. Beyond this point, however,

FIGURE 5. *Wye Branch in the Horetzky Adit of Power Tunnel No. 1*

the component elements of the power development are unusual in North American practice, corresponding more closely to many large and modern hydro-electric plants in Switzerland, France, Norway, Brazil, and elsewhere. The most striking characteristic is that the pressure conduits and the power-house proper are placed a considerable distance inside the mountain mass. There are many reasons for this:

1. Exposed steel penstocks for high-head power developments involve a maximum amount of steel as the penstocks must be designed to withstand safely and indefinitely the normal maximum pressure plus pressure surges arising from sudden rejection or pick-up of load.

2. With suitable rock cover, a considerable reduction in the tonnage of steel can be secured, as the pressure conduit or conduits replacing the exposed penstocks only require such a thickness of steel liner that the steel and the encasing grouted concrete-backfill and rock together can safely resist indefinitely the maximum stresses imposed in service.

3. Costly exposed penstocks can be replaced by a shorter pressure conduit or conduits, the discharge from the water-wheels being carried through free-flow (non-pressure) tailrace tunnels. Offsetting this are the costs of the tailrace tunnels, access tunnels to the underground power plant, power cables between generators and transformers on the surface or, if the transformers are located underground, between the transformers and outdoor switchyard.

4. Massive supports and anchorages are required for exposed penstocks, and rock conditions are not always uniformly suitable for foundations.

5. Exposed penstocks, especially those in high-head developments, are vulnerable to enemy air action. Pressure conduits deep inside the mountain mass are not.

6. Steep mountain slopes, heavily forested, present a fire hazard arising from normal inspection and maintenance activities.

7. Should a fire occur on the penstock slope, the burnt-over slope would become vulnerable to potentially dangerous snow and rock-slides.

8. No maintenance of underground pressure-conduit external surfaces is necessary, but it definitely is with exposed penstocks.

9. An underground powerhouse, deep inside the mountain mass, is free from enemy air action. More economic foundations for massive powerhouse equipment can be secured, since rock conditions at the foot of a steep slope rising from a valley floor deeply filled with fluvio-glacial deposits, or with heavy talus, necessitate costly foundation work.

10. The marked advances since World War II in underground excavation and construction technique, particularly in the use of tungsten-carbide-tipped drill steel and bits, have resulted in lower excavation costs.

11. Construction work on exposed penstocks on a steep mountain slope would be practically impossible during the winter season with a heavy treacherous snow cover, but it can be carried on throughout the year with underground pressure conduits. To a substantial extent work can be carried out on the power plant proper through severe winter conditions more expeditiously and more economically than with a surface plant.

12. The use of concrete in an underground power plant is minimized. Why substitute concrete for rock of better quality?

13. No structural maintenance is required with the underground power plant.

14. More equable working conditions are available with the underground power plant, a factor of some significance as far as personnel are concerned.

The pressure-conduit system for the first half of the ultimate 16 unit installation at Kemano will consist of the following elements, from the outlet end of the 25-foot diameter No. 1 power tunnel, proceeding downstream:

1. A surge chamber or shaft excavated in the rock;

2. A steel wye, branching into two 11-foot diameter pressure conduits, each controlled by an 11-foot diameter oil-pressure-actuated butterfly valve located about 300 feet below the wye;

3. Just downstream from the butterfly valve on each pressure conduit an air-inlet valve, to admit air into the pressure conduit whenever it is drained for inspection and maintenance;

4. An 11-foot diameter pressure conduit about 4,000 feet long, serving four units;

5. At the lower end of the pressure conduit a manifold, symmetrically

branched at 45° offsets and tapered to four 5-foot diameter branch pipes, each serving one 140,000 h.p. generating unit;

6. About 140 feet downstream from the first or major wye in the manifold, spherical valves located in an underground valve chamber, drained to the tailrace. These valves will be approximately 140 feet from the centre line of the units.

PRESSURE-CONDUIT DESIGN

The basic design of the pressure conduit involves the use of a steel liner, which will serve as a watertight diaphragm, and as an inside form for the concrete backfill placed between the steel liner and the rock sheath. Under operating conditions, the hydrostatic pressure in the conduit will be carried partly by the steel and partly by the weight of the overlying rock. At the powerhouse and valve chamber openings, the steel carries the entire stress arising from the internal water pressure. The concrete backfill and rock encasing the steel liner will be thoroughly grouted at suitable pressures to fill all voids and seams in the encasement, and to consolidate the rock so that a thoroughly reliable and uniform structure is secured.

The shaft for the pressure conduit is being driven at an angle approximately 48° from the horizontal, through an adit at the power house level to approximately 1,600 feet, at which level an adit will permit raising the upper half of the shaft, also at an angle of approximately 48° from the horizontal. A moderate offset in the pressure conduit at the mid-point adit has been provided to facilitate construction operations.

The spherical valves controlling flow to each turbine will be double-seated, with cast-steel bodies; the body seat rings will be movable, and their operating controls so arranged that the upstream seals are normally disengaged. Designed to pass a maximum flow of 555 c.f.s., under normal operating conditions, the 51 in. diameter valves will be under a maximum velocity of 39·2 f.p.s. Maximum velocity in the 5-foot branch pipes will be about 23·6 f.p.s.

Nothing has been left to chance in the design of the pressure conduit. In addition to thorough and independent reviews of outstanding high-head power developments employing pressure conduits in Switzerland, France, Norway and elsewhere, particularly as to design and construction, weaknesses which have shown up in such plants elsewhere have been carefully examined.

The properties of the rock through which the pressure conduits pass was investigated by means of a 10-foot diameter test sphere encased in rock and concrete, and subjected to a test pressure of 3,600 p.s.i., virtually three times the pressure to which the pressure conduit will be subjected. Analysis of the test results show that an average modulus of elasticity of the rock at 1,500,000 p.s.i. could be taken, corresponding closely to the value predicted in advance of the test. In addition, all phases of liner fabrication and jointing have been thoroughly investigated, special tests being run in many instances in order to verify predictions based on general knowledge and experience.

The pilot raises for the initial two pressure-conduit shafts have been already driven and slashing to full size, driving downward, is under way.

UNDERGROUND POWER PLANT

Factors influencing the decision to construct an underground power plant, deep inside the mountain mass, have already been stated. It may not be generally known that about 100 such plants have been or are being built, scattered all over the globe. Where the underground hydro-electric power plant meets the geologic and economic conditions, neither geography nor climate affect their use. Neither head, flow nor size limit development of water-power resources by means of underground power plants.

Underground hydro-electric power plants have been built in all types of geological formations comprising igneous, metamorphic and sedimentary rocks. Many of the underground plants, as in Sweden and Switzerland, are built in sound hard rock such as granite, requiring practically no support. Some are in badly fissured and even somewhat disintegrated rocks, which require substantial and nearly continuous roof support.

Although not commonly known, the first underground power plant in the world was inspired by a Canadian plant at Niagara Falls. This plant, built in 1895, has its turbines in a pit, with vertical shafts extending up 140 feet to the generators housed in a powerhouse on the surface.

The plant referred to is that at Snoqualmie Falls, Washington, where a 10,000 h.p. plant was completed in 1898 to develop the hydraulic energy of the 270 foot falls. Turbines, generators and control boards are located in a chamber 200 feet long, 40 wide and 30 high, hewn out of solid basaltic rock. This plant has been in successful operation ever since. The Snoqualmie plant was placed underground to avoid excessive spray and ice conditions arising from its proximity to the falls. Experience has shown the plant to be clean, dry and well ventilated. The powerhouse chamber is unlined, the solid rock making this unnecessary.

Access to the Kemano powerhouse will normally be through an access tunnel

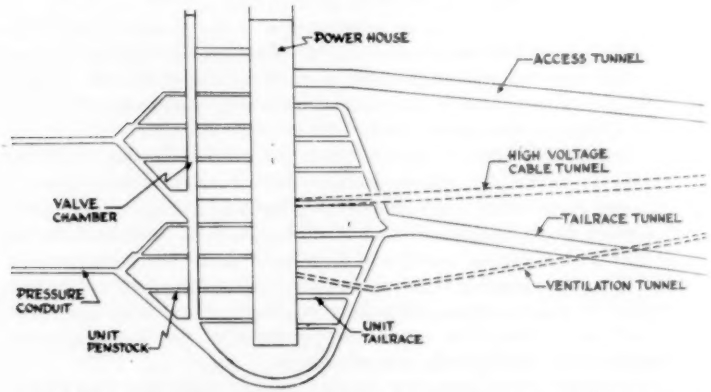


FIGURE 6. *General excavation plan for Kemano underground generating station*

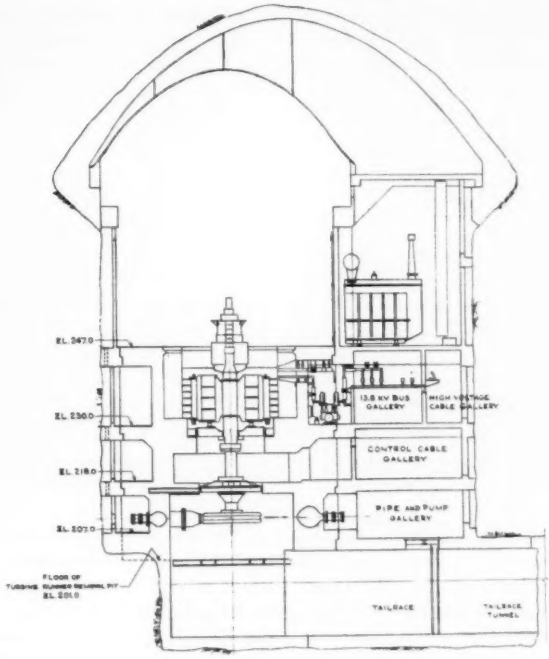


FIGURE 7. *Kemano Power Station: cross-section*

with a length of about 1,400 feet, the upper portion of which will serve as an ingoing air duct. The access portion of the tunnel is about 22 feet in width and 14 feet high. Emergency access or exit will be afforded through the ventilation tunnel, which serves as a pilot access tunnel during construction.

The Kemano generating station involves the excavation of a chamber 1,135 feet in length, 81 feet in width and 134 feet in height, excavated from the solid rock of the mountain mass.

Fig. 6 illustrates the general excavation plan for the generating station. It indicates the pressure conduits, manifolds, unit branch connections, valve chamber housing the spherical valves, the station proper, tailrace tunnel, and the access, high-voltage cable and ventilation tunnels for the first half of the development.

Fig. 7 is a section through the generating station showing the turbine and the runner removal pit and staging; the generator, associated circuit breaker, low-voltage bus gallery; and the control cable, the pipe and the high-voltage cable galleries. It will be observed that removal of a turbine runner will be

effected by lowering the runner to a car on tracks on the staging at 201 feet above sea-level (El. 201) and moving the car with runner back to the removal pit without in any way disturbing the shaft, the bearing or the generator.

As the main transformer banks will be installed in the generating station, much thought was given to two basic considerations:

1. Limitation of damage in the event of major trouble on a transformer.
2. Rapid replacement of a damaged transformer.

The first consideration was provision of a tripartite pit between the deep floor beams, capable of holding the entire 7,000 Imp. gal. oil content of a transformer. A 12 in. diameter drain from each element of the pit leads downward directly to the nearest tailrace. The vault fronts will be covered by fire doors; roof hatches with very light, free-resting, metal covers provide relief to the plenum chamber above the vaults; and an extensive mulsifyre-spray system with four automatic temperature detecting devices completes the fire protection features.

The second consideration was predicated on replacement of a faulty transformer in not over three hours. The heat exchangers are moved with the transformers, enabling the use of only four dresser couplings for pipe connections. The installation being independent of weather conditions, all auxiliary leads for oil-pump motors, indicators and alarms are effected by plug-and-socket connections with flexible armoured cable. The four low-voltage connections require the maximum time, but at least three men can work simultaneously on these. The transformer will be rolled forward out of its vault, picked up by one crane, and the spare unit put into place, using the second crane if necessary.

The installation of the main transformer banks underground is not unusual, such a procedure having been followed in many European underground generating stations, where the high-voltage rating runs up to 380 kV.

The generating station will be served by two 225-ton cranes.

EQUIPMENT

The Kemano power plant, when completed, will have installed 16 vertical, single-runner, four-nozzle impulse turbines, each rated 140,000 to 150,000 h.p. at 327 r.p.m. Each waterwheel will drive a direct-connected, vertical, three-phase, 60 cycle, 327 r.p.m. 13,800 volts, 0·8 power factor generator rated at 106,000 kVA at 60°C. temperature rise and 122,000 kVA at 80°C. rise with main and pilot exciters, with a short-circuit ratio of 1·0 and WR^2 of almost 24,000,000 lbs.-ft.^{2} These generators will be able to carry 115 per cent of the 60°C. rating continuously.

Each group of two generators will feed into a double-primary bank of three single-phase, 71,000–89,000 kVA transformers, rated at 300 kV.

The output of the transformers will be delivered to the switchyard at the surface, through 300 kV oil-filled (60 p.s.i. oil pressure) power cables, 2,150 feet to 2,260 feet in length. These cables will be about 4 in. outside diameter, 515,000 CM, single copper conductor, paper insulated. The initial order for

FIGURE 8. *Excavation in progress below the roof-arch of the powerhouse chamber, at Kemano*

cable was split between two manufacturers, one of whom will supply cable with an aluminium sheath and an aluminium conductor. The 300 kV cables will be carried on open racks in two cable tunnels. The 600-volt station service will be provided through 2,500 kVA transformers tapped from the generator 13·8 kV leads. All control and relaying will be housed underground.

The design provides for the turbine runners being set with nozzle centre line at 210 feet above sea-level. One group of eight units will discharge to a tailrace tunnel 1,050 feet in length and the other eight to a tailrace 1,100 feet in length. At the downstream ends of the tailrace tunnels, with invert at 174 feet, open-cut channels will complete the tailraces, discharging to the Kemano River.

At this time, the arch section of the powerhouse has been excavated and the roof arch concreted and grouted for the first half of the ultimate development. Excavation of the rock below the arch section is now well under way. Fig. 8 shows this work in progress. Tunnels associated with the powerhouse and the valve chamber have been substantially excavated.

Fig. 9 affords an overall view of the Kemano construction camp.

OPERATORS' HOUSING

A small village will be necessary at the power plant to accommodate operating and maintenance personnel. This will be constructed not far from the power station, where a suitable site is available in the Kemano Valley.

FIGURE 9. *Kemano construction camp, from the opposite side of the Kemano Valley*

TRANSMISSION SYSTEM

From the power plant the first ten miles of the transmission system will comprise two double-circuit tower lines, gradually climbing to about 1,000 feet above sea-level, at which point these feed into a switching station with motor-operated selector disconnect switches. The outgoing lines will consist of two single-circuit transmission lines, running up to a maximum altitude of about 5,300 feet in a distance of 10·6 miles. Here another switching station will be located, at 500 feet, from which two double-circuit tower lines will run the remaining distance to the terminal station at the Kitimat aluminium-reduction plant. In this stretch of the line about 5 miles will run between 2,000 and 3,000 feet.

Designing for the transmission of 1,670,000 h.p. firm delivery at Kitimat through relatively narrow valleys, having regard to potential snow and rockslides at some points, and across a narrow mountain pass with a maximum altitude of some 5,300 feet, is a difficult problem. The snow may lie 20 feet or more deep during the winter months, and icing conditions may be very severe, with a short construction season. Moreover, the transmission lines must provide absolutely reliable service, because the aluminium-reduction process is a continuous one.

Early in the investigations it was recognized that the Kemano and Kildala River sections of the transmission-line route did not provide much more than sufficient space for two double-circuit transmission lines. The 10·6 mile stretch

through the Kildala Pass at elevations up to 5,300 only provides space for two tower lines, due to the extremely rough terrain. This section also was recognized as being difficult of access and undoubtedly subject to heavy icing conditions. This is due to the orographic influences on the warm moisture-laden winds from the Pacific, and the influence of snowfields and glaciers, the snouts of some of which approach the route rather closely. It was obvious that very rugged construction of the transmission circuits through the Kildala Pass would be necessary.

Because the country through which the transmission lines will pass is uninhabited and its weather unrecorded, in the fall of 1950 a test span of 795,000 CM ACSR was erected between two 26 feet high aluminium towers, at an elevation of 5,300 feet on the summit of Kildala Pass, some 2,000 feet above the timber line. A crew of observers was stationed in cabins along the transmission route and the site of the test span was provided with recording instruments. During the winter of 1950–51 the maximum ice loading observed was 2·4 lb. a lineal foot. Obviously, conditions occurring during one winter are not necessarily the most severe which can arise.

Extensive investigation of icing on transmission lines in mountainous territory in Switzerland, Italy, France, Norway and Sweden was also carried out. Results of investigations made in these countries at experimental installations for icing observations were studied. One of these was the experimental station installed on the summit of the Puy de Dome in south-central France, at an altitude of 4,806 feet. Here the rainfall is fairly heavy, high winds are experienced, and in winter the formation of glaze and rime loads is severe; probably worse than encountered in any other mountainous area in France. At this station, a maximum ice load of about 27 lb. per foot has been experienced.

Lightning hazards are of such low frequency over the route traversed by the transmission lines, that no ground wires are being provided except for one mile at each terminal.

For the double-circuit tower lines, standard ACSR 54/19 (Falcon), 1,590,000 CM cross-section, with an outside diameter of 1·545 in. and a weight of 2·032 lb. per foot is being used. Ultimate strength of this conductor is 55,400 lb. The double ground wire at the terminals will be $\frac{3}{4}$ in. diameter HS steel cable, with an ultimate strength of 50,000 lb. Insulation will comprise sixteen 10 in. by $5\frac{3}{4}$ in., 25,000 lb. M and E, standard suspension units in suspension strings and 18 in strain strings. Single strings will be used for suspension points, with double strings for long spans. At strain points triple strings will be used.

For the single-circuit tower lines through Kildala Pass, the conductor will be ACSR, with an outside diameter of 2·295 in., a weight of 4·77 lb. per foot, and an ultimate strength of 135,700 lb., the cross-sectional area being 3,364,000 CM. The same type of insulators as used on the double-circuit tower lines will be utilized, except there will be 18 units in suspension and 20 in strain strings. Triple or quadruple strings will be used for suspension, according to requirements, and sextuple strings for strain applications. A maximum insulator swing of 36° from the vertical is allowed.

It may be noted, at this point, that the conductor, fittings, clamps and other

components were all subjected to design-proof tests, so that all components would develop the maximum strength of the insulator strings.

One of the two single-circuit transmission lines across Kildala Pass will be built with steel towers, of generally conventional design. The suspension—light angle towers will weigh about 35 tons each; the heavy angle-strain type will be substantially heavier, depending on height. The other single-circuit transmission line across Kildala Pass will be built with aluminium towers, using a design of which a prototype has been successfully built and thoroughly tested. This design is a braced H-frame type tower with five thin-walled aluminium tubes about 38 in. in diameter and a box-girder cross-arm. These towers will weigh substantially less than the corresponding steel towers and are expected to show substantial economies in transportation, erection and maintenance.

Because the electrical loading of the transmission system, at 1,670,000 h.p. firm delivery at Kitimat, represents a far heavier load than has hitherto been transmitted fifty miles over a transmission system as outlined, and because the reliability of service must be high, the whole system was set up on a network analyser, taking into account the necessary characteristics of the generating equipment, the step-up and step-down transformers, the transmission circuits and the mercury-arc power-conversion equipment at the load.

This investigation revealed that the transmission of 1,235,000 kW at 92 per cent power factor over one-half of the transmission system would require about 400,000 kVar. of condenser capacity, or 33,000 kVar. per load step-down transformer bank, as contrasted with a normal maximum requirement of about 15,000 kVar. per bank. Maximum voltage required at the generating station terminal will be 302 kV.

A construction road to service transmission-line construction has been driven over the mountains and is substantially complete. Right-of-way clearing is largely finished. A number of towers have already been erected.

ALUMINIUM-REDUCTION WORKS

The reduction plant, or smelter, is being built partly on the delta of the Kitimat River, and partly on alluvial fans that have been deposited on the edge of the delta by two creeks which discharge from the mountain slopes to the west.

The Kitimat River is a relatively short water course, and the delta materials are coarser than usual, varying from silty sand to small gravel. The alluvial fans are gravel and coarse sand. Foundation conditions are fairly good, but the whole area is low, running from slightly below high tide up to 30 feet above high tide, and the water table is high. The buildings are therefore being built on a compacted gravel fill, up to 30 feet high at the lowest part of the site. Ample quantities of sandy gravel are available, but a haul of about two to three miles is required.

The harbour works are in the tidal region of the delta. A dredge cut will be excavated through the tidal flats, and a wharf consisting of large concrete boxes floated into place, then sunk and filled with gravel, will be built at the edge of the

cut. Two rock moles have been built to contain the dredged material, in an area between the wharf and the smelter. This hydraulic fill will be used for storage space, and for some relatively light buildings; owing to its low-bearing capacity, no important buildings will be built on it during the early years.

Cargo handling equipment is now being developed to handle bulk alumina (aluminium oxide), as well as other bulk materials, and aluminium ingot. Owing to the abrasive qualities of alumina, and to the tidal range of over 20 feet, careful attention is being given the design of bulk unloading towers.

At the aluminium-reduction plant, the terminal station will be somewhat similar in arrangement to that at the generating station, except that there will be ultimately 12 step-down transformer banks, normally each supplying a single pot-room with bussing facilities to permit transfer of power to other loads, a bank for miscellaneous load and a spare bank. It is visualized there may be synchronous condensers, but most of the corrective capacity will be in the form of static capacitors on the low-tension side of the step-down banks.

For communication between Kemano generating station and the Kitimat aluminium-reduction works, power-line carrier facilities will be installed.

The step-down transformer banks are single-phase OFW type transformers rated at 37,000 kVA, with a voltage ratio of 275/13·2 kV, with four 2·5 per cent taps, the neutral being solidly grounded.

Each cell line or potline will be supplied by eight mercury-arc rectifier equipments, of the ignitron type in the initial establishment, each rated at 12,500 kW. These equipments comprise a single-tank, 1,200 amps., 1,000,000 kVA interrupting capacity, outdoor oil circuit breaker, a self-cooled phase-shifting transformer rated at 13,200 kVA (of which two provide 15° phase shift, four 7·5° shift, and two 0°) and arranged to give 48 phase operation, a self-cooled rectifier transformer rated 13,200 kVA, with a three-phase primary and two six-circuit wye-connected secondary windings. These 12 windings supply the 24 anodes of two rectifier frames, each consisting of 12 pumped, ignitron-type, water-cooled rectifiers with auxiliaries. The cathodes of the 16 frames are connected through high-speed air circuit breakers to the positive main D.C. bus. The neutral points of all secondary windings are connected to the negative D.C. bus, through interphase transformers. The rectifier equipment is expected to have an efficiency of somewhat over 96 per cent, from the 13·2 kV A.C. bus to the 1,000 volt D.C. bus.

TOWN SITE

Not the least of the many problems is the development of a town site intended ultimately to house 50,000 people. Planning and engineering for the town site in such a remote area, with no initial facilities, has required the services of a number of specialists, all of whom feel that, in spite of difficulties due to climate, sloping ground, gullies and heavy timber cover, there is a unique opportunity at Kitimat to produce a community free from the inherited mistakes and congestion that cause so much expense in other places.

The town site is across the Kitimat River and four miles up the valley from the smelter. A railroad is being built by the Canadian National Railways, to

connect with their Prince Rupert branch at Terrace, 40 miles north of Kitimat, and a highway may be built along a parallel route.

SALIENT FACTS ON NECHAKO-KEMANO DEVELOPMENT

Among the outstanding features of the Nechako-Kemano hydro-electric development are:

1. When completed, it will be the largest underground power development in the world, having a firm capacity over three times the ultimate installed capacity for Sweden's Harspranget development and about 1·7 times that for Brazil's combined Forcacava No. 1 and No. 2 plants.

2. When completed, it will have an installed capacity substantially in excess of Boulder (Hoover) Dam and be exceeded only by the now completed Grand Coulee development of 2,250,000 kW.

3. When completed, it will have an annual firm energy generation well in excess of the estimated 8,100,000,000 kWh firm from Grand Coulee.

4. The Kenney Dam across the Nechako Canyon is the third highest rock-fill dam in the world.

5. The Nechako storage reservoir will have a capacity only exceeded by Boulder Dam's Lake Mead and by Fort Peck and Garrison Dams, in the United States of America. It will be twice that of Grand Coulee.

6. The vertical turbines will be the world's greatest capacity impulse type units.

7. The 2,600-foot head, 11-foot diameter pressure conduit is, so far as known, not exceeded by any other built or under construction today.

8. The 300-kV oil-filled power cables will constitute the highest voltage power cables in service in North America and the second highest in the world, only exceeded by the 380 kV cables at Harspranget in Sweden.

9. The transmission-system loading will be the world's highest, by a substantial margin; the conductors will be the largest ever fabricated.

10. The Kitimat reduction works will be the world's largest aluminium smelter when completed.

DISCUSSION

SIR SELWYN SELWYN-CLARKE, K.B.E., C.M.G. (Chairman, Commonwealth Committee): I should like to say how much I have enjoyed this fascinating, erudite address of Mr. Lawton's, and I should like to ask him one question. That is: why was British Columbia chosen as the area for development?

He told us earlier on in his talk that the raw materials were being brought from Jamaica and partly from the eastern seaboard of Canada, and yet this scheme, this magnificent, colossal scheme, is apparently being developed over on the western side of Canada.

THE LECTURER: The answer is, perhaps, not obvious from the description of the project, but it was decided by two conditions: one, that cheap power can be created in British Columbia at this particular site, and the reason why it can be created is because hydro-electric engineers sometimes pull rabbits out of hats and turn what is known as 'invisible' water power into visible water power. In other words, with

development in the ordinary fashion there would be very little power because the total drop in the river level there would be spread over some hundreds of miles, but by diverting it through these 10·1 mile tunnels, it is possible to obtain the entire 2,600-foot head at one location.

The other factor, of course, is that cheap transportation exists. We still have some water power in eastern Canada, but it is not necessarily such that it is economic for the production of aluminium.

MR. J. ROSEN, B.SC.: May I ask a question about the Volpa River scheme proposed in West Africa? It seems to me a much more economical scheme, because you have raw material immediately available and power supplies adjacent. It seems to be an undertaking capable of more economic development than in this very mountainous country of Canada.

THE LECTURER: That is a fair question, but I would like to remind you that the official decision to build in British Columbia was taken in April, 1951, and we will be turning out metal in April, 1954. In other words, the construction of the British Columbia development will have been carried out in about three years. The shortest estimated construction time for the Volpa Scheme, under normal conditions—in other words, without putting on the pressure which runs up the cost—is, according to my information, in the order of seven years.

A vote of thanks to the Lecturer was carried with acclamation; and, another having been accorded the Chairman, the meeting ended.

GENERAL NOTES

SOME IMPORTANT EXHIBITIONS

It is saddening, if scarcely surprising in our necessitous times, that the economics of art increasingly overshadow other considerations. It is not what the Arts and British Councils do, but what they spend, that engrosses the gossips; not the value of a masterpiece to the spirit of man, but its value in the market that exercises envious minds. At the same time, widest publicity is given to the increasing number of competitive exhibitions in which substantial prize money is involved. Thus the general public first learned of the existence of Mr. Reg Butler, the pioneer of 'open' iron sculpture, through the irrelevant circumstance of his winning £4,500 in an international competition, allowing him the brief notoriety of a bar-tender who wins the Treble Chance. More than ever to-day it seems necessary to preserve a just sense of values, and to give the accountant his proper place in the scheme of things.

It is symptomatic that the National Gallery's recent acquisition of its first Cézanne should have attracted wide attention simply through the unauthorized disclosure that the cost was around £30,000—not an exorbitant figure, in any case, in view of American competition. Since Cézanne's death half a century ago, his portrait of *La Vieille au Chapelet* has always been owned by private French collectors, and could not pass into our national possession until Jacques Doucet's widow decided to dispose of it a short while ago. The subject of the picture, which now hangs in Gallery XV, is a nun who had lost her faith and eventually her reason, and was cared for by the painter. He represented her brooding over her rosary in a canvas that occupied him constantly in 1898–99. The simple, yet exceedingly subtle planes of the head have been apparent even in monochrome reproduction, which could not however suggest the resonant scheme of black, blues, and violet in this, one of the most profoundly meditated of Cézanne's portraits.

The total prize money of £3,000, offered (to mark its ninetieth anniversary) by the Football Association for pictures and sculpture devoted to Soccer, was no doubt a necessary incentive to draw as many as 1,700 entries, reduced to 160 by a responsible jury, and lately shown at Park Lane House. The Arts Council has arranged that Sheffield, Blackpool, Birkenhead, Aberdeen, and other towns in the North and Midlands will have this chance of seeing many of our serious and promising artists tackling a subject much less familiar to them than to the critical layman. Indeed, there is something slightly ludicrous in the notion of a general sally from ivory towers to stadium seats, though a few abstractionists remain obstinately true to form, producing pictures that have little or no relevance to the theme. In general, the painters are scarcely equal to the task of representing players in fleeting action, and many of the best canvases seek to convey the peculiar atmosphere of stadiums and arenas. L. S. Lowry (the most deserving of the prize-winners) has one of his deceptively naïve paintings of spectators converging on a stadium, very subtle in colour and finely organized in depth; while the melancholy that descends when players practise to empty stands is sensitively communicated by L. L. Toynbee. The prints and drawings are mostly unremarkable, but the sculptors respond with some lively pieces, among them Willi Soukop and Eric Peskett with their vigorous goalies, and F. E. McWilliam with a space-time experiment in which his attenuated figurines are disposed in high relief on a vertical slab, representing the field of play. This wins a sculpture award; but whether Bootle will endorse the choice is another matter.

The exhibition of paintings of the 'Cities of Canada' (which has succeeded the Football works at 45 Park Lane) will appeal especially to Fellows who have links with that fertile and progressive country. This collection is yet another result of enlightened patronage, for it was the Montreal firm of Seagram which commissioned Canadian artists to depict the cities of their land, rising from its seacoasts, plains, and mountain shelters; and the collection of fifty paintings and sketches now reaches us in the course of its world tour. The breadth of design and simplification of detail lend a number of pictures a somewhat posterish appearance, and panoramic views are often obtained by depicting the scene from an eminence. At the same time there is an agreeable variety of styles, without any assertion of extravagant moods, and the artists have honestly tried to convey the essential character of the places, as was required. A. Y. Jackson, perhaps the most distinguished painter in the company, emphasizes the shapes of undulating cliff and buildings in his prospect of St. John's, Newfoundland, contriving a closely knit and harmonious design; Albert Cloutier, formerly a war artist to his country's Air Force, makes an admirable pattern out of the trees and paths of Dominion Square, Montreal; and some other painters could be named who survey their cities with perceptive eyes, doing for Canada very much what the best of our topographical artists did for Britain in the Pilgrim Trust's valuable scheme.

By contrast, the Contemporary Art Society's exhibition at the Tate Gallery disappoints just because so many painters fail to comply with the reasonable requirements. The Society invited a hundred serious British artists to paint largish compositions of 'Figures in their Settings', undertaking to buy eight, and only ruling out unrepresentational pictures which were clearly inadmissible. Abstract artists were invited to contribute (in addition to realists), no more being expected of them than the barest adumbration of figures in their surroundings.

In the result, the sixty paintings on view in three rooms include several complete abstractions, an inexplicable painting of a large snake, and a number of townscapes in which tiny figures make merely a token appearance. Henry Lamb, John Minton, John Napper and Elinor Bellingham Smith tackle the problem with varying success, and Ceri Richards makes a real effort with an imaginative design of a patient being lifted into bed, much less abstracted than the run of his work, and the most satisfying

canvas here. The exhibition has, at least, the melancholy advantage of showing that the kind of picture which exercised the finest creative minds of past time has largely ceased to concern our most discussed contemporaries.

Tate visitors may also now see, hung in the sculpture galleries, the replicas of medieval frescoes in Yugoslav monasteries. The earliest wall-paintings, dating from the eleventh century, are clearly by Byzantine masters, but the thirteenth-century decorations of monumental grandeur from the Mileseva and Sopoćani monasteries show ideas spreading much more from Italy, and the advance towards individual, or at any rate more human, characterization is as marked as in Cimabue's art. With the development of narrative painting and portraits from life in the next century, the early serenity is lost, though the iconography is still wonderfully inventive and so remains in the fifteenth century frescoes, late Gothic in character, with which the exhibition closes.

If these wall-paintings have rather a specialist than a general appeal, there can be nothing but admiration from any quarter for the Roman portrait busts, brought from Italy to 4 St. James's Square. Here the question in every visitor's mind is whether any part of this heritage may ever come to bear a relevance to our own 'progressive' sculpture. The exhibition, in fact, ranges over a thousand years from Etruscan works to the contemplative busts of the fifth century; the masks of Emperors stirring the historic sense, as the formal relationships and changing subtleties in the treatment of hair again and again excite the receptive eye. An unforgettable collection.

NEVILE WALLIS

THE MODULAR SOCIETY

The Modular Society held its first annual general meeting at the Society's house on Wednesday, 28th October. At the meeting a constitution was adopted, an executive committee of 24 members was formed, and Sir Alfred Bossom, Bart., M.P., was elected first president.

The first public meeting of the session will be at the Society's house in the evening of Wednesday, 16th December.

OBITUARY

LORD KENILWORTH

We record with regret the death, on 3rd November, of the Right Honble. Sir John Siddeley, first Baron Kenilworth, at the age of 87. Lord Kenilworth's successful career as a motor car manufacturer began when, after early days spent as a draughtsman at the Humber cycle works at Beeston, he was picked out by the managing director of Dunlop's and became interested in the use of the pneumatic tyre for motor cars. In 1904 he arranged for the Wolseley Car Company to make a car to his specifications. In 1908 he entered into partnership with the late Major Deasy to produce the Deasy car, later, on Deasy's retirement, to be known as the Siddeley-Deasy. In 1919 the company was merged in the Armstrong-Whitworth Development Company, which itself became part of the Hawker-Siddeley group in 1923. Apart from his production of the Armstrong-Siddeley car, he also developed the Puma aircraft engine. He received a knighthood in 1932 and was raised to the Peerage in 1937, in which year he was elected President of the Society of Motor Manufacturers and Traders. He was also at one time President of the Society of British Aircraft Constructors.

He was elected a Fellow of the Society in 1919 and was a Vice-President from 1938 to 1941.

NOTES ON BOOKS

MODERN PUBLICITY, 1953–54. *Edited by Frank A. Mercer. Studio publications*, 1953, 35*s*

As each new issue of *Modern Publicity* appears, one is forced to acknowledge how considerable a service its publishers and editor perform, year by year, for everybody with a stake in the creative side of advertising. Larger and more elaborate volumes have been seen, and are welcome. But job for job and price for price *Modern Publicity* (which once cost 10*s* 6*d*, and even now has been forced no higher than 35*s*) outstays and outvalues them all.

Job for job . . . but what is its job? Is it a reference book? Is it a portable exhibition? Start to consult it as you would the telephone directory and you find yourself beguiled and inspired. You cannot easily criticize it for omissions (you do not see its *Salon des Refusés*). If one year is 'better' than another, the fault may as easily lie in the dull brains of copywriters or the lazy minds of art directors as in the blindness of the editorial selection committee. If I tell you *Modern Publicity*, 1953–54, is well up to standard, do I really mean that all in all, on each side of the Atlantic, our profession has had a good year?

The value to us of this particular international review surely lies just there: in our confidence in its selective judgment, its eye for the very small changes of direction which are representative of any given year, its coverage, its accuracy and its standards of display and reproduction. In all these respects *Modern Publicity* shows the wisdom and instinct we expect of it—and in doing so, indicates once more how dull and liverish a place the world could be without the salt of competitive advertising.

This, the twenty-third issue of *Modern Publicity*, contains representative advertising work from thirty-two countries of the world, and since all the examples must, of necessity, be reproduced in miniature the result can be confusing. It is difficult to assess the merits of any one advertisement, poster or piece of print when it is surrounded by eight other examples on a page 9 inches by 11.

It is difficult to know whether an advertising campaign is effective by looking at one isolated example. Advertising is a long term operation, and each piece is but one item in a scheme of things. Unless one knows what is the ultimate aim, and what is the policy behind the operation, it is unwise to pass judgment on a single advertisement.

But these are limitations which must be taken for granted in judging the success or otherwise of such a book as this. And if one contemplates the magnitude of the undertaking, if one tries to imagine the amount of material which has been sifted, shifted, arranged and displayed, I think that one must admit that the job has been professionally well done.

CECIL D. NOTLEY

BLAYE, ROLAND, RUDEL AND THE LADY OF TRIPOLI. *By Michael Barrington. Salisbury, Bennett Brothers*, 1953. *Stiff paper cover*, £1 19*s* 6*d*; *Buckram gilt*, £2 15*s* 0*d*

There is an increasing number of persons who are convinced that only by a renaissance of true religious sentiment will civilization escape complete destruction from the forces of materialism. At such a moment as the present no work could be more timely than Michael Barrington's, for it reveals and clarifies with inspirational strength the meaning of the Crusades, the ages of faith and chivalry, and their influence on noble minds since the days of the troubadours. The central theme is the story of Prince Rudel of Blaye's idealistic love for Princess Odierna, the Lady

of Tripoli. Mr. Barrington, some of whose historical works, such as *Grahame of Claverhouse*, are classics, has combined his exceptional knowledge of the Middle Ages, and literary truth, with profound poetic vision. This book cannot fail in time to become a standard work on the Era of Chivalry.

ADRIAN BURY

SHORT NOTES ON OTHER BOOKS

BRUSH SCRIPT. *By Donald Stevens. Batsford*, 1953. 10*s* 6*d*

The author explains in his introduction the materials and methods necessary to write a brush script of good style and appearance, and follows this with a single phrase written in a great number of different styles, and finally with pages of capital letters each in a dozen forms.

AN APPROACH TO PLANNING. *By T. H. B. Burrough. Pitman*, 1953. 21*s*

This discussion of the theory of planning deals with the planning of buildings, both in relation to their surroundings and internally; the author illustrates his theme, which is treated, as he says, from first principles, by a great number of drawings.

CATALOGUE OF FRENCH PAINTINGS. *Glasgow art gallery and museums association*, 1953. 5*s*

In addition to the complete catalogue of French paintings in the Glasgow Art Gallery, this handsomely produced book contains sixty reproductions of some of the most notable pictures, a number of which are in colour.

FURNISHING THE SMALL HOME. VOLUME 2. *By Margaret Merivale. Studio publications*, 1953. 15*s*

This guide to the task of furnishing the small home in a contemporary fashion consists of a large number of illustrations of rooms in which it has been successfully attempted, many of them being from North America and Scadinavia. There are also shown a number of pieces of furniture particularly suitable for small rooms, and of equipment which would be desirable and suitable in any circumstances.

FROM THE JOURNAL OF 1853

VOLUME I. 11*th November*, 1853

From the Opening Notice

As the Session commences on Wednesday next, the present is thought the fitting period for closing the first volume of the *Journal*, so that the new one may begin with the opening of the Session. . . . The Members have now had one year's trial of the *Journal*, and it is confidently believed that whatever doubts and fears for its success might have existed at the starting, the experience of the year has shown that there need be none now. It has supplied a want, and with success. In saying this, however, it must not be supposed that the Council are blind to its deficiencies or shortcomings—they are well aware that it is not yet all they could wish, or what they trust it will become. The experience of the past year has shown what may be done, and affords good ground for anticipating a further success in the ensuing Session.

Some Activities of Other Societies and Organizations

MEETINGS

MON. 16 NOV. Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. *Illuminations and Decorative Lighting* (Discussion).

Geographical Society, Royal, S.W.7. 5.30 p.m. W. G. V. Balchin and N. Pye : *Deserts of Arizona and California.*

Imperial Institute, S.W.7. 5.45 p.m. A. W. Wakefield : *Off the Beaten Track : With the Grenfell Mission in Labrador.*

Transport, Institute of, at Jarvis Hall, 66 Portland Place, W.1. 5.45 p.m. R. G. Grout : *The Short Sea Trade.*

TUES. 17 NOV. Chadwick Trust, at the Royal Sanitary Institute, 90 Buckingham Palace Road, S.W.1. 5.30 p.m. John A. Logan and R. P. Burden : *The Public Health Significance of Environmental Control by Engineering Means.*

Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. G. A. Gauld and R. J. Newport : *Construction of Two Concrete-Lined Tunnels for the Machkund Hydro-Electric Project, South India.*

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. A. H. M. Arnold : *Alternating-Current-Instrument Testing Equipment.*

Industrial Transport Association, at the Royal Society of Arts, W.C.2. 6.30 p.m. A. A. Harrison : *The Railway Outlook on Freight Transport.*

Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, 3. 6.30 p.m. W. R. Mead : *Finland.*

Refrigeration, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. 5.30 p.m. Dr. R. A. Kekwick and Dr. R. F. Strickland-Constable : *Freeze Drying.*

WED. 18 NOV. British Kinematograph Society, at the G.B. Theatre, Film House, Wardour Street, W.1. 7.15 p.m. A. W. Watkins : *Stereophonic Sound Systems.*

Eugenics Society, at the Royal Society, Burlington House, W.1. 5.30 p.m. G. Aird Whyte and C. P. Blacker : *Possible Future Activities of the Eugenics Society.*

Folk-Lore Society, at University College, Gower Street, W.C.1. 7.30 p.m. Miss Christina Hole : *Popular Modern Ideas on Folklore.*

Microscopical Society, Royal, Tavistock House South, Tavistock Square, W.C.1. 5.30 p.m. Prof. F. W. Jane : *The Frontiers of the Plant and Animal Kingdoms.*

Photographic Society, Royal, 16 Princes Gate, S.W.7. 7 p.m. S. D. Jouhar : *Exhibition Photography.*

Textile Institute, at Electricity Showrooms, Union Street, Oldham. 7.30 p.m. H. Sagar : *Fibres and Processing Aids.*

Victoria & Albert Museum, S.W.7. 6.15 p.m. John Beckwith : *Design in Medieval Textiles.*

THURS. 19 NOV. Chemical Society, at the Institution of Civil Engineers, S.W.1. 7.30 p.m. Prof. A. Tiselius : *Some Applications of the Separation of Large Molecules and Colloidal Particles.*

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. R. F. Sims : *The Wear of Carbon Brushes at High Altitudes.*

Locomotive Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. 5.30 p.m. H. I. Andrews : *Stresses in Locomotive Coupling and Connecting Rods.*

Petroleum, Institute of, at 26 Portland Place, W.1. 6 p.m. W. F. Jelfs : *Calibration of Tanks and Tankers.*

Road Transport Engineers, Institute of, at the Royal Society of Arts, W.C.2. 6.30 p.m. H. Rossington : *The Costing of Vehicle Maintenance.*

FRI. 20 NOV. British Sound Recording Association, at the Royal Society of Arts, W.C.2. 7 p.m. Baynham Honri : *The Case History of a Sound Film.*

Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. Sir Richard Southwell : *Relaxation Methods : A Retrospect.*

SAT. 21 NOV. Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. B. Rackham : *Pottery—A varied Art.*

MON. 23 NOV. Electrical Engineesrs, Intitution of, Savoy Place, W.C.2. 5.30 p.m. A. E. Falkus : *Loudspeaker Systems—Recent Trends in Design.*

Geographical Society, Royal, S.W.7. 8.15 p.m. Prof. Frank Debenham : *New Light on Livingstone's Last Journey.*

Imperial Institute, S.W.7. 5.45 p.m. R. H. Aldrich : *Off the Beaten Track : By Road, River and Trail in British Guiana.*

TUES. 24 NOV. Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. Conrad Gribble : *Bridge Investigation, Ceylon Government Railways, 1949-51.*

Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, 3. 6.30 p.m. A. J. Whiteman : *Living Reefs of Andros Island, Bahamas.*

WED. 25 NOV. British Kinematograph Society, at G.B. Theatre, Film House, Wardour Street, W.1. 7.15 p.m. H. Ibbotson : *Medium Screen Television.*

Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. N. Troost : *A New Approach to the Theory and Operation of Electrostatic Precipitators for Use on Pulverized-Fuel-Fired Boilers.*

Victoria & Albert Museum, S.W.7. 6.15 p.m. Helen Lowenthal : *The English Gentleman and the Grand Tour* (1) *The Journey Abroad.*

THURS. 26 NOV. Engineers, Society of, 17 Victoria Street, S.W.1. 6 p.m. Colin Hills : *Cosmetics, Past and Present.*

FRI. 27 NOV. Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. (1) R. F. Darling : *Fuel Systems and Controls for Marine Gas Turbines* (2) B. E. G. Forsling : *Main Propulsion Gas Turbine Set for the Oil Tanker* Auris.

Textile Institute, at 10 Blackfriars Street, Manchester, 3. 3 p.m. B. M. Sweers : *Economic Aspects of the Textile Industry in Europe.*

SAT. 28 NOV. Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. W. F. Grimes : *Burial Customs in Prehistoric Britain.*

OTHER ACTIVITIES

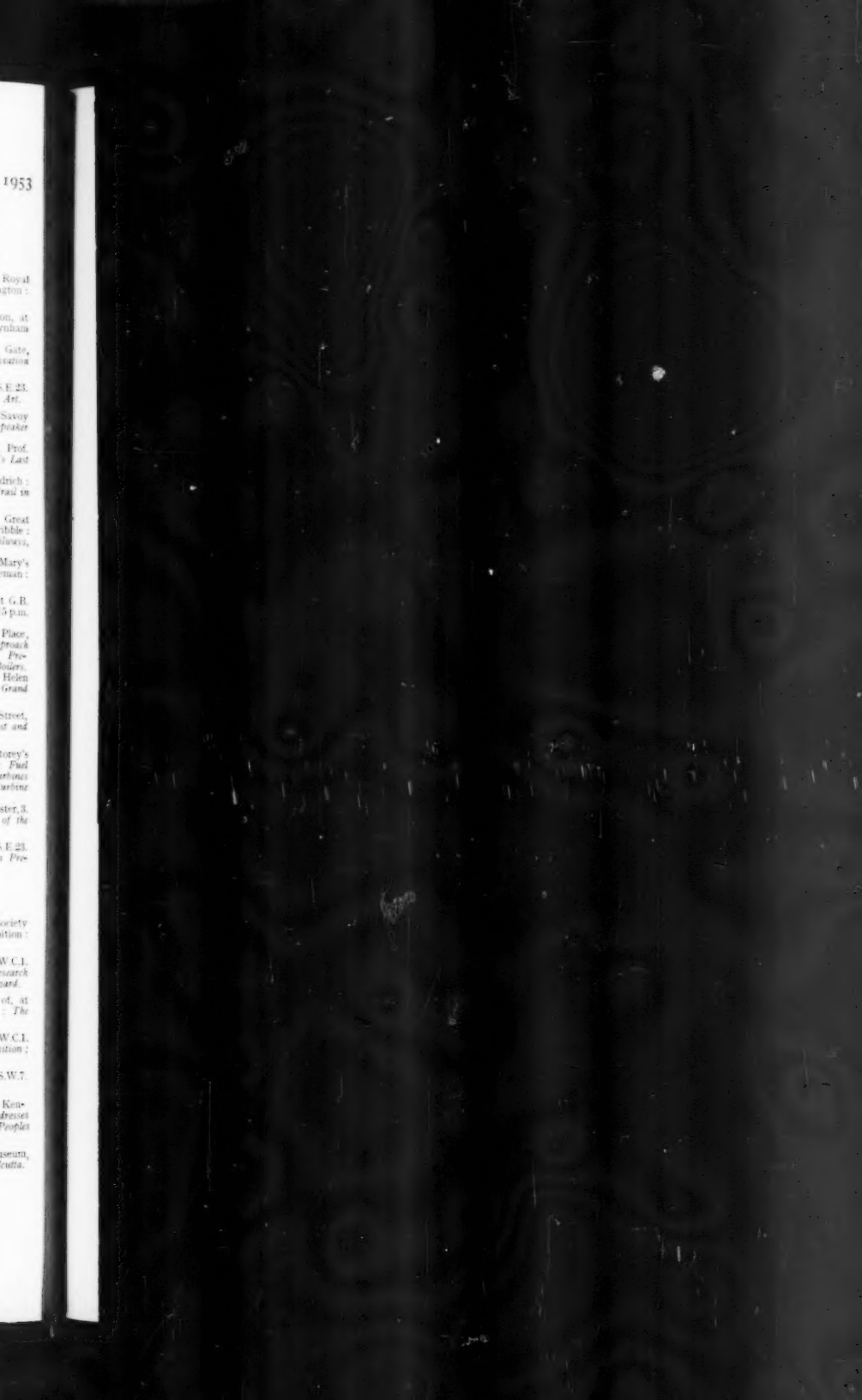
TUES. 17 NOV. UNTIL 22 DEC. Portrait Sculptors, Society of, at the Imperial Institute, S.W.7. Exhibition : *The Famous in Sculpture.*

WED. 18 NOV. Building Centre, 26 Store Street, W.C.1. 12.45 p.m. Film Show : *Parapet Walls ; Research and Modern Housing ; Reducing the Fire Hazard.*

WED. 18 NOV. Chemical Engineers, Institution of, at Caxton Hall, S.W.1. 5.30 p.m. Film Show : *The Stanlow Story.*

WED. 25 NOV. Building Centre, 26 Store Street, W.C.1. 12.45 p.m. Film Show : *A Concrete Proposition ; Aerated Concrete.*

NOW UNTIL SUN. 17 JAN. 1954. Science Museum, S.W.7. Exhibition : *Navigation To-day.*

NOW UNTIL JAN. 1954. Imperial Institute, South Kensington, S.W.7. Exhibition : *Loyal Addresses Presented to Her Majesty by the Colonial Peoples on the Occasion of Her Coronation.*

NOW UNTIL APR. 1954. Victoria & Albert Museum, S.W.7. Exhibition : *Bazaar Paintings from Calcutta.*